SEPTEMBER 1956

# CHEMICAL ENGINEERING PROGRESS

SPECIAL NUCLEAR ISSUE

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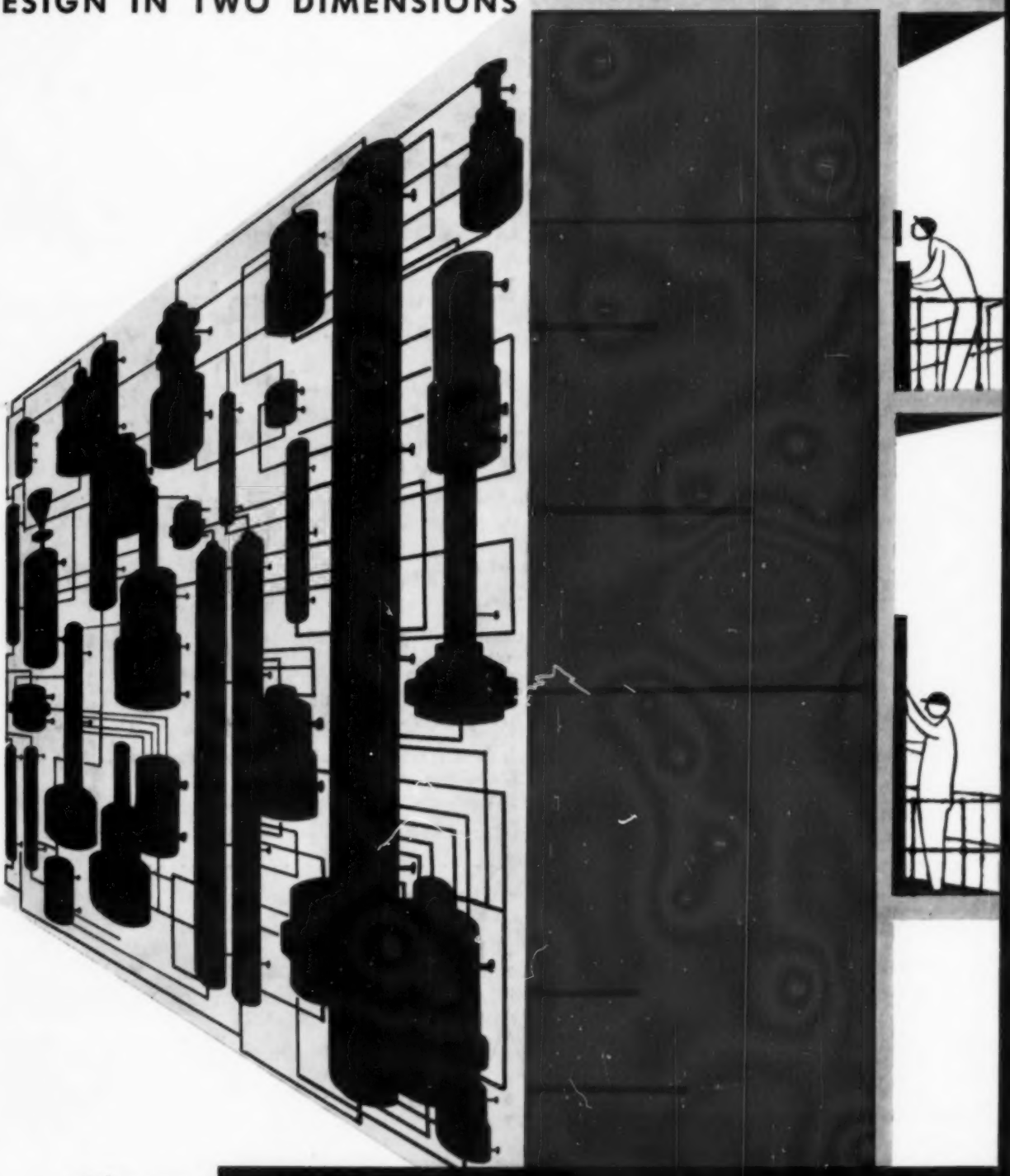

Theme: Unit Operations in Nuclear Engineering

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Chemical Engineering Progress

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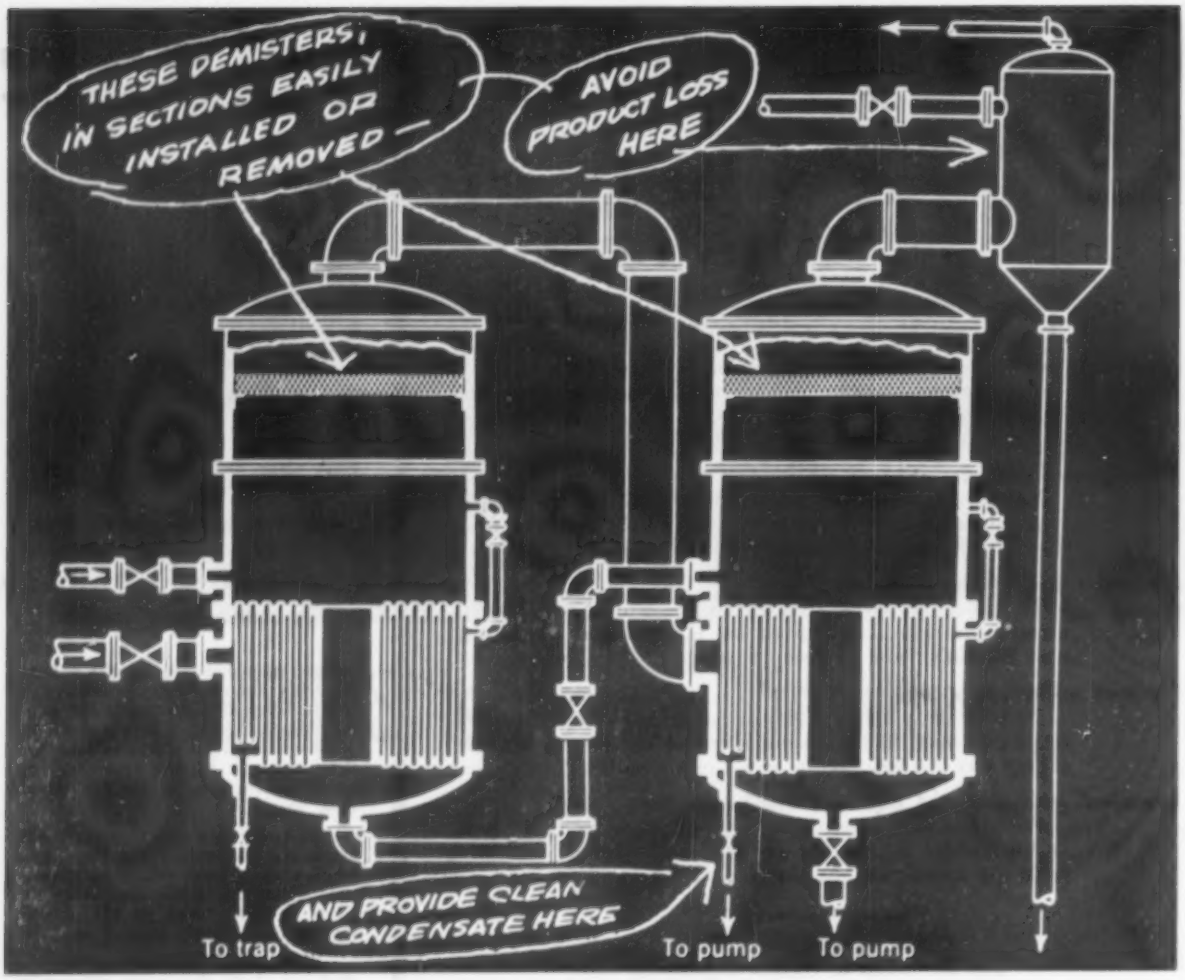
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*Cover design by*
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# what's in this issue

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has the major advantage of lowering required height of expensive, shielded building structure.

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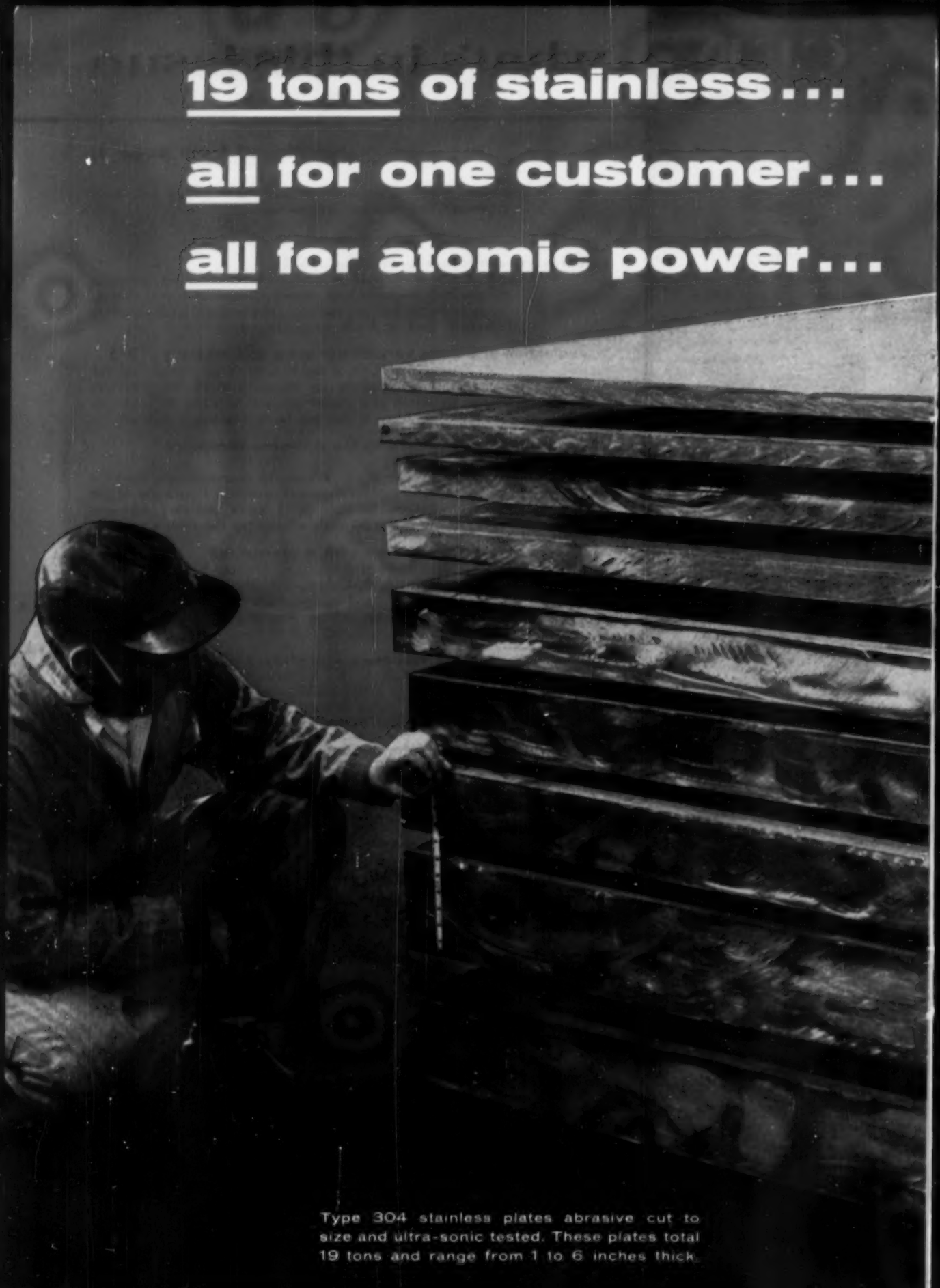


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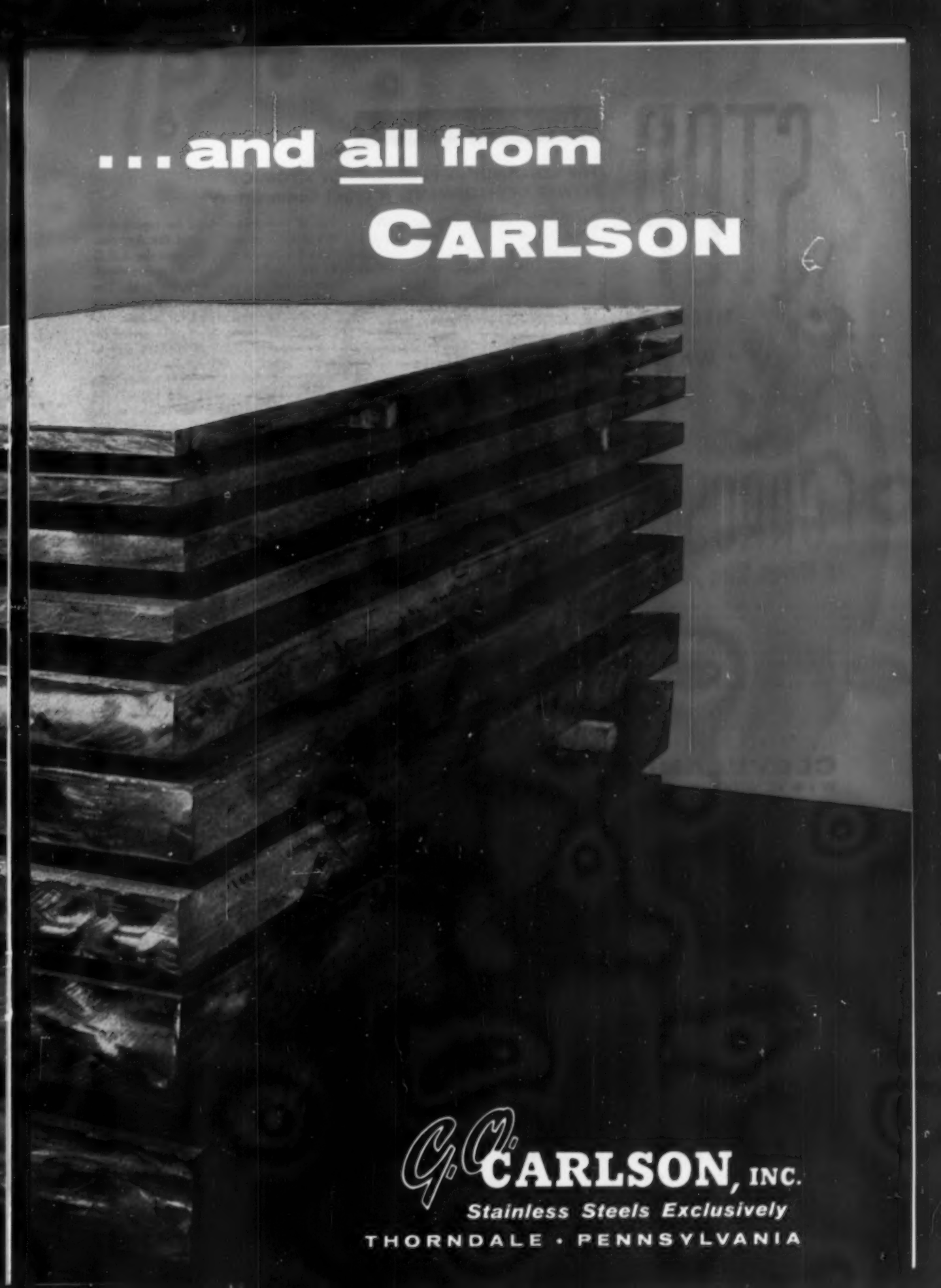
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## Marginal notes

### THE CONTINUING PROBLEMS OF ATOMIC POWER DEVELOPMENT: A Legal Commentary

**Atomic Power Development. Winter issue of Law and Contemporary Problems. Duke University, Durham, North Carolina, (1956), 210 pages, $2.00.**

*Reviewed by Lee Loevinger, Attorney at Law, Minneapolis, Minnesota.*

*Law and Contemporary Problems* is a distinguished quarterly published by the Law School of Duke University, each issue of which contains a symposium in which a number of authors seek to elucidate some particular contemporary problem having legal significance. There is, however, little of a technical legal nature in the symposium devoted to atomic power development. Rather, the effort seems to be to acquaint lawyers, few of whom know the difference between fission and fusion, with the scientific, economic, and political aspects of the 1954 Atomic Energy Act.

A large part of the difficulty in understanding or discussing problems of atomic power development stems from the fact that the physical processes involved were developed largely as a military and wartime measure under conditions of the utmost secrecy. In 1946 Congress passed a statute establishing the Atomic Energy Commission, but maintaining a tight government monopoly over all materials and processes related to atomic phenomena, and establishing strict controls over all information related to such matters. Legal title to all fissionable material was in the government, and possession or use of such material was subject to complete control by the A.E.C.

In 1954 a new statute was passed to govern all phases of the development of atomic energy. The A.E.C. remained the dominant locus of power in the field although numerous provisions in the new land were designed to encourage civilian use and private exploitation of atomic energy, radioactive isotopes, and similar phenomena. Under the Atomic Energy Act of 1954 a program was instituted to create a private atomic power industry. This publication is largely devoted to a discussion of the difficulties in the way of the program, the manner and speed with which it may operate, and the social, political and economic implications of its operation.

Under the 1954 Act private ownership of both atomic materials and facilities is permitted, although only under license from the A.E.C. Patents on developments in the field are permitted, but all inventions must be reported to the A.E.C. promptly, and the Act contains provisions which permit the A.E.C. to require licensing at reasonable royalties under any patent in the field. The A.E.C. not only must license any activity but also sets the prices for atomic materials, and may, when an activity involves experimental or military significance, grant subsidies. Since virtually all present work in the field has at least as much experimental and military as industrial significance, the power of the A.E.C. in this direction is limited only by its own discretion.

The A.E.C. has produced small amounts of power in experimental reactors, but the first actual atomic power plant in this country is not scheduled to begin production until the fall of 1957. This will be a 60,000 kw. plant at Shippingport, Pennsylvania, being built by the Duquesne Light Company. Although this will produce commercial power, the cost of production will undoubtedly be higher than for power produced by fossil fuels. Whereas there are some differences of opinion, a conservative prediction appears to be that atomic power cannot be produced at a cost that will be commercially competitive until at least 1968. Prior to that time, commercial construction of atomic power facilities will probably all be subsidized, either directly by the A.E.C. or indirectly by including the uneconomic cost in the charges to consumers. It is estimated that the operating utility of the Shippingport plant will have paid less than half the total cost of its construction. In addition, the development of atomic energy utilization to date has, of course, been almost entirely at government expense, and involves a large investment. Thus there is some ground for arguing that atomic power development involves exploitation of a "public resource," and the whole subject is deeply immersed in the public vs. private power controversy.

A complicating factor in the situation is that the companies which have participated under contract with the government in the atomic research and development program prior to this time, have acquired a vast amount of experience and information which is not yet available to others. Restrictions on the dissemination of information confine such data to those who can demonstrate a need for it. There is serious doubt whether the present security program, as

(*Continued on page* 10)

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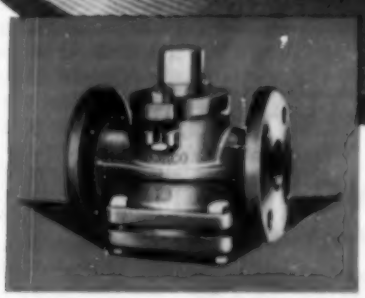

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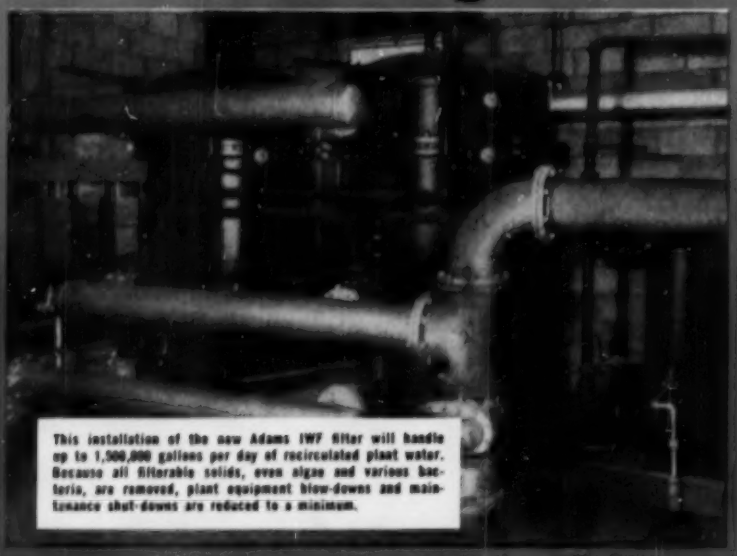

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## Marginal notes

(*Continued from page 8*)

applied to private industrial activity of the kind contemplated in the future development of atomic power, is either desirable or workable. Nevertheless the program exists and will apply to any individual or enterprise that seeks to work within this field. Thus some feel that there is a genuine danger that the government, which officially forbids monopoly in private industry, will through this program create a new and immensely powerful monopoly.

The security program which limits the amount of information that can be made public, of course, inevitably curtails public discussion of the issues involved in administration of the atomic energy program. What we do with our facilities, know-how, and resources in this field will also have widespread influence among other nations and on our relations with other nations. The significance of the program and its ultimate effects cannot be foreseen and can hardly be overestimated.

It seems clear that the Federal regulatory scheme has so occupied this field that the states are left with no role to play except that of agents or licensees of the A.E.C. Although Congress has prescribed the general outline of what may and may not be done in an unusually long and detailed statute, the ultimate power of control has been effectively left with the A.E.C. While such administrative control is now a common legal device, the unusual aspects of this subject, its newness, its secrecy, its military importance, combine to give the A.E.C. extraordinary and almost unprecedented power.

This publication contains a number of discussions of the extent and implications of that power, and of how it is likely to be exercised, that are lucid and helpful to anyone interested. One who has had any substantial experience with administrative regulation cannot help but feel some uneasiness concerning the power of the A.E.C. over our lives, and the possibility of its being used as wisely as a more widely dispersed or publicly exercised power might be. Although the discussions in this publication are somewhat reassuring, they by no means answer all questions or satisfy all doubts. One suspects there may be issues not noticed here. Perhaps there is an issue as to whether the use of this vast new force shall be controlled by lawyers, scientists, or engineers. Perhaps there is a question as to whether we have not unleashed a force that none of us can control. (Does

(*Continued on page 18*)

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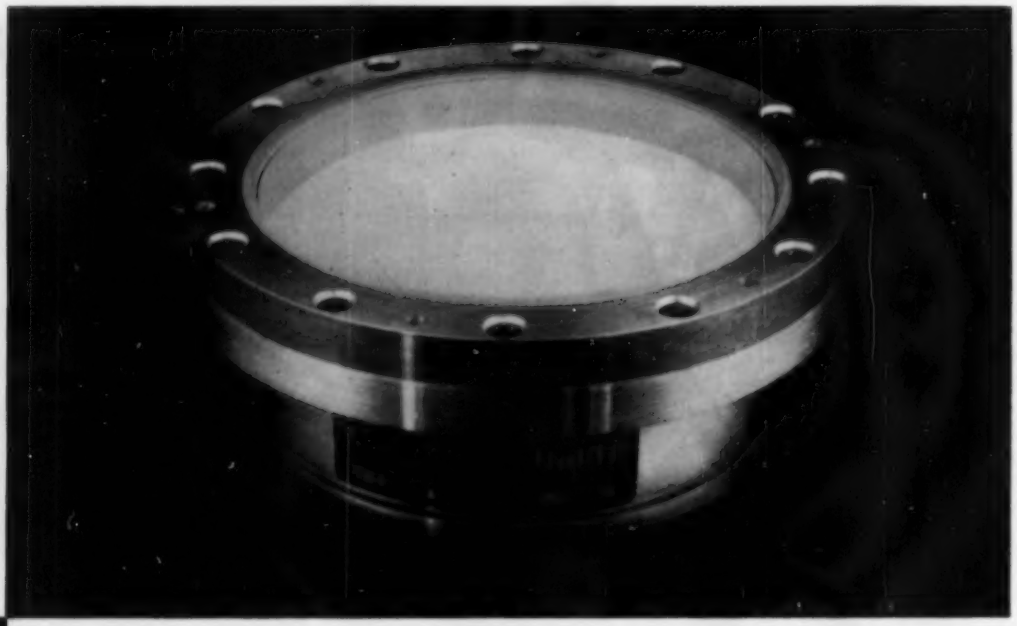

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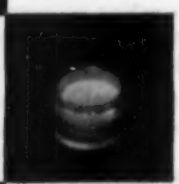

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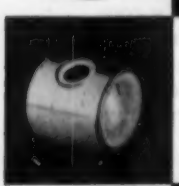

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BOILERS for Power and Heat . . . High and Low Pressure . . . Water Tube . . . Fire Tube . . . Package Units

**FORGE DIVISION**

Crankshafts . . . Pressure Vessels . . . Hydraulic Cylinders . . . Shafting . . . Straightening and Back-up Rolls

**MACHINERY DIVISION**

MACHINERY for Sheet and Structural Metal Forming . . . Tangent Benders . . . Folding Machines . . . Roller Table and Tumble Die Bending Machines . . . Press Brakes . . . Punching and Notching Machines . . . Forming Dies

**STRUTHERS WELLS Corporation**

Struthers Wells

WARREN, PA.

Plants at Warren, Pa. and Titusville, Pa.

*Offices in Principal Cities*

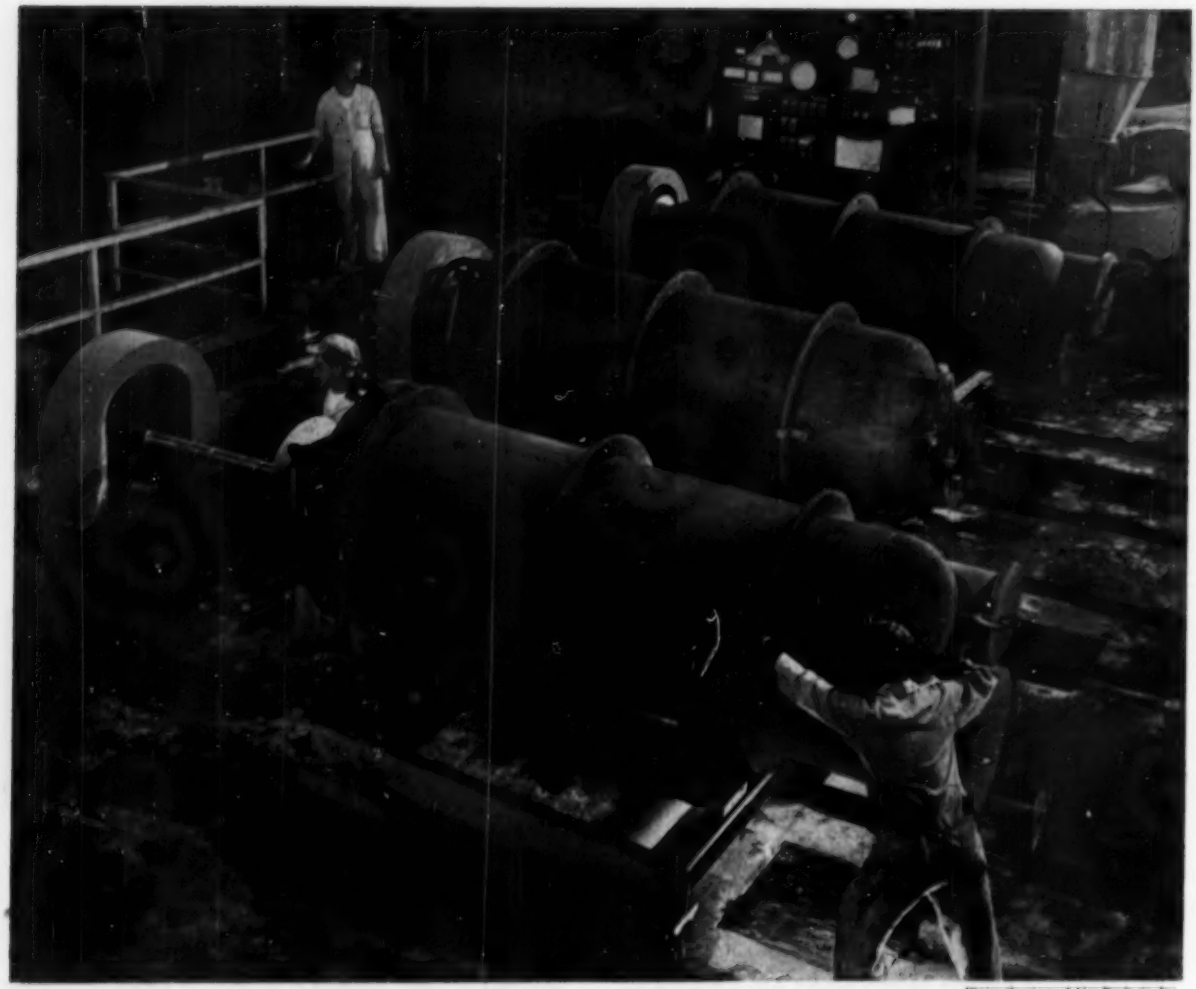

Photo: Courtesy of Alco Products, Inc.

**Positioning unplated vessel** into place for plating its interior with a durable coat of nickel. By prolonging the useful life of process equipment, nickel plating pays for itself over and over.

# Nickel plating protects product purity ...is economical

**Economical protection against mild corrosive attack** is provided by nickel plating of reasonable thickness.

Equally important, plating safeguards product purity during production cycles.

*Records show that considerable savings have been made* by processors of food, chemical, petroleum and scores of other products through use of nickel-plated equipment.

**Complex shapes now no problem**

Heretofore, electroplating was limited to small, simple forms. Large complex shapes posed several difficulties. But no longer, thanks to technical advances along with expansion and improvement of facilities.

*Today, new techniques permit plating the most intricate shapes* with a uniform, extremely hard, corrosion-resisting nickel coating. Even those of low-cost base metals.

*Dependability of these advances has made it practicable* to nickel-plate large quantities of equipment to meet exacting demands of the Atomic Energy Commission. And, likewise, to meet the needs of processors.

**Investigate how nickel plating can save you money**... by protecting your equipment from corrosion and your product from contamination. Also, by cutting the initial cost of your equipment. Send us details of your metal difficulty. We'll be glad to give you suggestions based on long practical experience. Write today.

INCO TRADE MARK

**THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N.Y.

**If You Classify Dry Powders and Want**

*Product Recovery of 80% to well over 90%*

BULLETIN NO. 1280

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# GET THE BEST SOLUTION TO EVERY FLOW

## . . . with Foxboro Instrumentation

### Differential Pressure Cell Transmitters

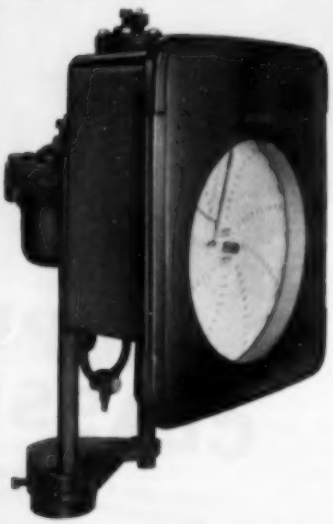
Complete line includes air-operated and electric-operated d/p Cell Transmitters covering ranges from 0-20" to 0-800" of water; working pressures up to 1500 psi.

### Type 13A d/p Cell Transmitter

- Positive Overrange Protection—up to full 1500 lb. rating
- Fully Adjustable Ranges—0-20" to 0-80" and 0-50" to 0-250" water
- Automatic Internal Damping — fast, stable measurement
- Simplicity—easiest, lowest-cost installation, lowest maintenance

### Mercury Type Meters

Complete line includes mercury types covering ranges from 2 to 400" of water; working pressures up to 5000 psi.



### Type 28 Mercury Meter

- Permanent Full-Scale Meter Accuracy — exclusive segmental lever design provides linear transmission from float to pen
- Highest-Powered Pen Drive — large float with long travel
- Minimum Ambient Temperature Effects — float located in high pressure chamber

# PROBLEM

### Foxboro Magnetic Meter

- Measures Fluid Velocity Directly
- Adds No Pressure Drop
- Uniform Flow Scale
- Overall Accuracy Better than 1% of Range Over Entire Scale
- Full Accuracy Sustained Even on Liquids Other Meters Can't Handle — even sand and water slurries

THERE ARE two logical reasons why Foxboro Instrumentation assures you *optimum* results in measurement or control of process fluid streams. First; Foxboro offers the widest variety of measuring and controlling devices . . . the *right* equipment for every application. For example, only Foxboro offers all these basic meter types: differential pressure cell flow transmitters, magnetic meters, mercury meters, and weir meters. Second; Foxboro provides 45 years of engineering experience in every phase of fluid mechanics. From the simplest general utility-type instrument to complex automatic ratio control systems, you get highest accuracy, efficiency, and economy. Whenever you have a flow problem involving liquids, vapors, gases, or slurries — in pipes, ducts, or channels, you can solve it best by specifying Foxboro. Only a few instruments are described on these pages. For full details; or for specific information on your problem, contact your nearby Foxboro Field Engineer, or write **The Foxboro Company, 939 Neponset Ave., Foxboro, Mass.**

**FOXBORO**
REG. U. S. PAT. OFF.

**FIRST IN FLOW**

*FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND*

### Float-and-Cable Type Meters

- Rigid Construction — weather-tight case; all working parts of corrosion-resistant materials
- Powerful Accurate Operation — large, high-stability float; cable of Type 302 Stainless Steel — non-stretching, non-twisting
- Direct Reading Chart and Scale
- Direct Reading Integral Counter

### Other Foxboro Flow Instrumentation

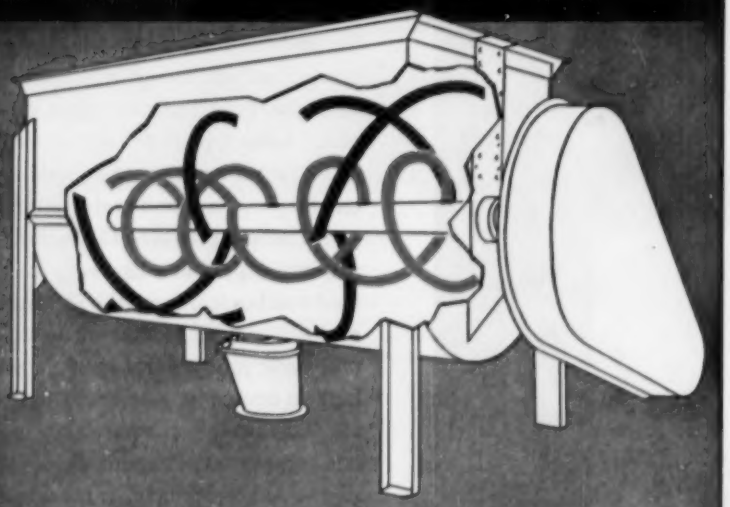
Electric or Pneumatic Type Rotameters

Electric, Pneumatic, and Mechanical Integrators

Planimeters

All Primary Elements, Valves, and Accessories required for assembly of complete flow measurement and control systems

FOR CONTINUOUS
OR BATCH OPERATIONS



Readco counterflow action

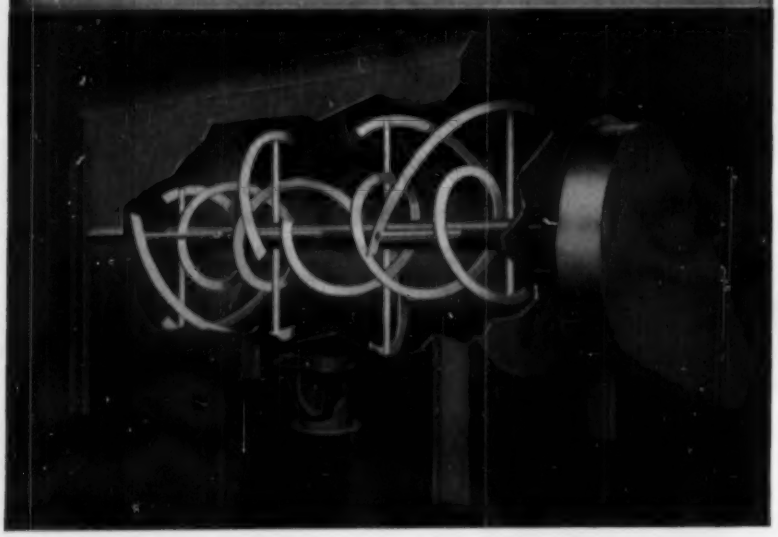
assures rapid, thorough mixing or blending of pulverized or granular, wet or dry materials.

Heavy-duty construction stands up under long runs and adverse processing conditions with a minimum of costly downtime.

Readco Spiral Ribbon Mixers can be supplied for atmospheric, elevated pressure or vacuum operation . . . with or without temperature controlling jackets. Working capacities up to 500 cubic feet.

BAKERY-CHEMICAL DIVISION
York, Pennsylvania

READ STANDARD
CORPORATION



## Marginal notes

(*Continued from page* 10)

anyone really have the vaguest notion of what we can do to dispose safely of all the radioactive waste material that atomic power development will produce?) While this publication leaves some questions unasked, and many more unanswered, it does serve as an excellent nontechnical introduction to the numerous social, political, and legal problems of atomic energy development in the years immediately ahead.

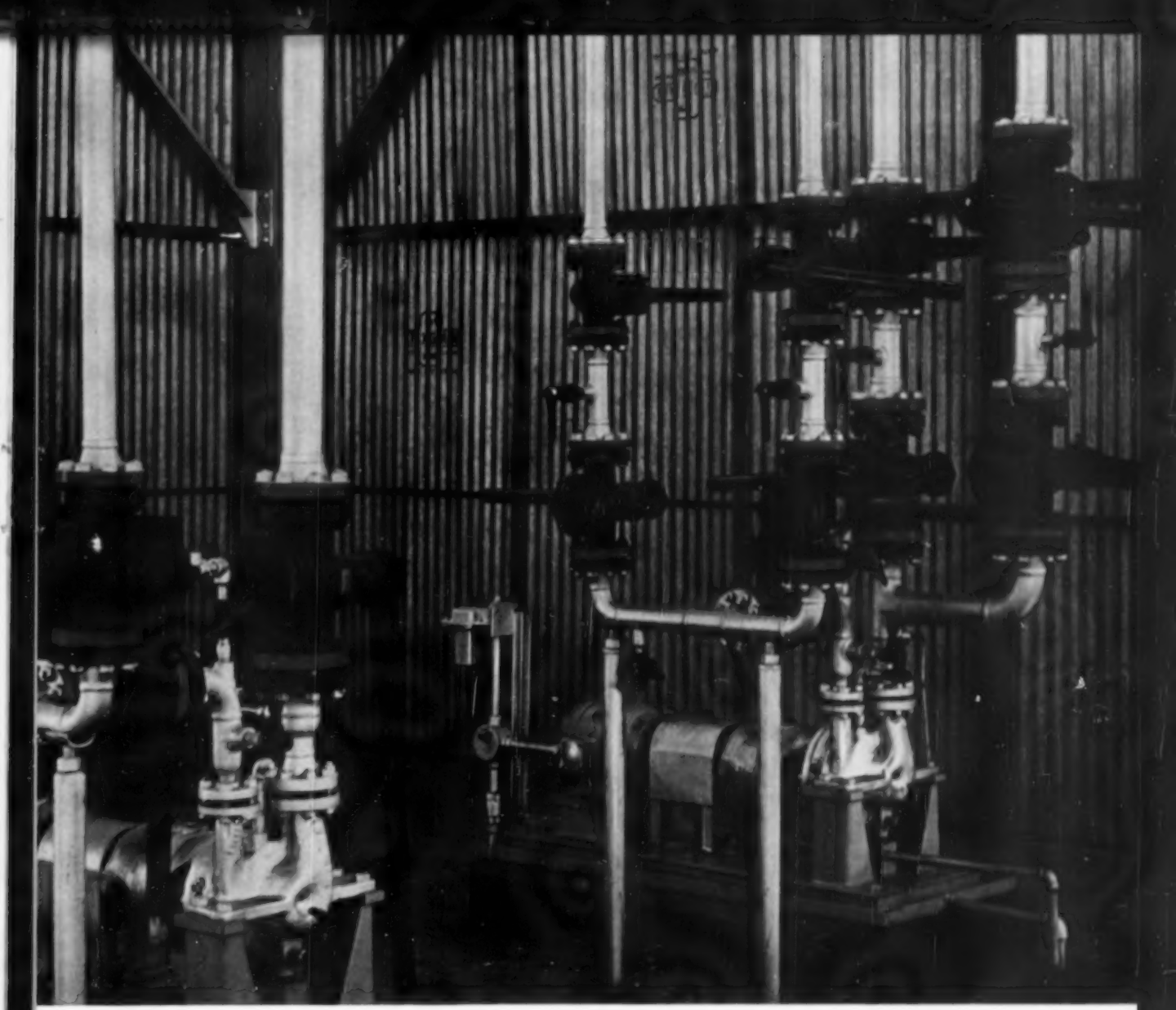
**Reactor Shielding Design Manual**
**Theodore Rockwell III, editor; McGraw-Hill Book Co., New York (1956), 466 pages, $6.00.**

*Reviewed by H. S. Davis, and R. T. Jaske, Hanford Atomic Products Operation, General Electric Company, Richland, Washington.*

The shielding of nuclear reactors is an interesting example of the difficulty which the uninitiated face in entering the nuclear field. Whereas it is true that mobile reactors offer additional complications, in general it serves to point out that the economical design of reactor shields requires extensive examination of many complex and interrelated factors on a scale hardly approached in everyday process design. There is no room for guesswork or crude approximation since success of the project is contingent on the proper handling of emission from the core and associated systems.

Data presented in this manual have been gathered from a wide range of sources, and while admittedly imperfect in detail, should be useful to reactor designers. The chapters include an outline of basic theory, discussion of allowable leakage, methods of estimating primary core radiation sources as well as activation of coolant systems, methods for computing shield thicknesses, a practical discussion of problems encountered in actual shield construction, and treatment of the accessibility problems resulting from radioactivity in the shutdown system. In addition, theoretical and empirical techniques associated with the geometry of sources and receptors are discussed thoroughly with considerable attention being placed on estimation of transmission through ducts, slots, and other shield irregularities. The treatment is comprehensive and readable, although in general, the occasional user will find the book more of a reference work than a guide to the solution of

(*Continued on page* 30)



# *The "extras" cost no more*

When you use Rockwell-Nordstrom valves you get "extras" you can't buy in ordinary valves. Pressurized lubrication in the Sealdport* system assures leakproof sealing (without uncertain "forced" seating), and eliminates costly wearing friction. Because they are rotary plug valves, quarter-turn operation and unexposed seating are two more money saving extras. The cost? Rockwell-Nordstrom valves cost no more to buy (often less) than ordinary valves and cost much less to use.

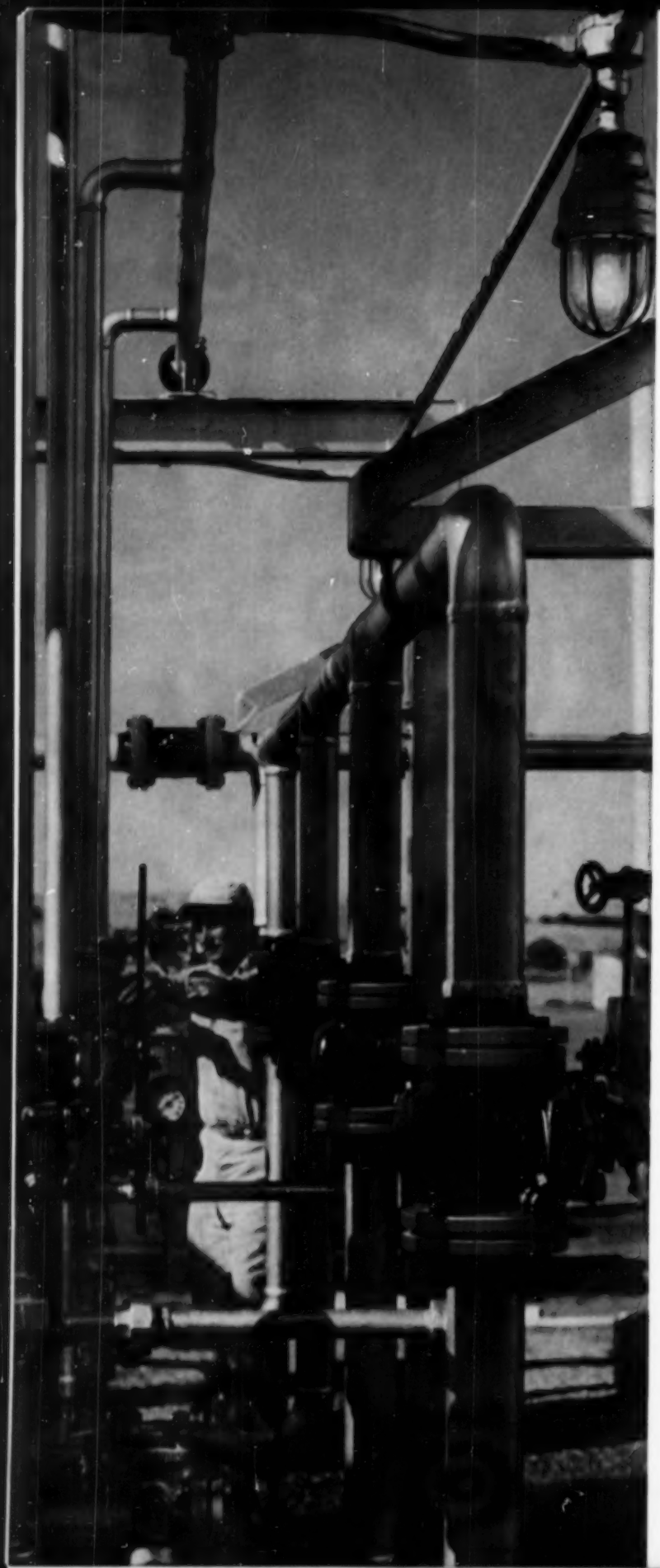
Forty years of lubricated plug valve leadership by the original and world's largest manufacturer is your assurance of economy and trouble-free dependability when you specify Rockwell-Nordstrom valves. Rockwell Manufacturing Company, Pittsburgh 8, Pennsylvania.

*A registered trade mark of Rockwell Manufacturing Company.

## ROCKWELL-Nordstrom VALVES

**Lubricant Sealed for Positive Shut-off**

40th Year *of lubricated plug valve leadership*



# *Complex manifolding made easy*

You can use Rockwell-Nordstrom valves in complex manifolds where ordinary valves wouldn't even begin to fit. Because they have no heavy, bulky bonnet cavities or rising parts, Rockwell-Nordstrom valves take little more space than their flange diameters. Additional advantages: positive shut-off prevents product contamination; firmly seated plug and rugged construction prevent shock load failures that are common to ordinary valves on pulsating flow.

Rockwell-Nordstrom valves cost no more to buy than ordinary valves—and they cost far less to *use*. Available in a complete range of sizes and pressure ratings in semi-steel, steel, stainless and corrosion resisting metals. For details, write: Rockwell Manufacturing Company, Pittsburgh 8, Pennsylvania.

*Available at leading suppliers . . everywhere.*

**ROCKWELL-**
Nordstrom
**VALVES**

**Lubricant Sealed for Positive Shut-off**

40th Year
*of lubricated plug valve leadership*

*Another client benefits from a BMC "Precious Plus"*

# Esso Unit Completed ... 21 days early!

To meet urgent production needs, a quick, quality job was desired on construction of a new process unit at an Esso Standard Oil Company refinery.

BMC Engineering accepted the challenge . . . and with a Key Man* in charge, put the unit on stream — at full capacity — *twenty-one precious days ahead of schedule!*

*Speed* was the need — with efficiency, of course. This was the "Precious Plus" in BMC's performance which never can be shown on blueprints — for it is the product of many intangibles. Other leading companies, too, find BMC's *plus* in performance of *precious* advantage. How else explain the unusual growth BMC is enjoying?

**You need new "yardsticks" to measure the *plus* performance of BMC.** For the abilities of this dynamic organization go far beyond what can be shown on blueprints — and it's such intangibles that add up to better plants, faster and at lower cost.

Creative engineering . . . whether your process problem is common or complex, BMC engineers solve it with "fresh" thinking that frequently produces *new* efficiencies, *unexpected* savings.

Unique experience . . . BMC Engineers are *more* than competent — most staff members are recognized *authorities* in their fields.

*Key Man operation . . . The BMC man who submits your proposal is *always* a BMC *principal* — *always* the Key Man responsible for the execution of your job. Clients say, "This is the BMC difference that makes the difference."

bmc

**BADGER MANUFACTURING COMPANY**

230 Bent Street, Cambridge 41, Massachusetts
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ENGINEERS • CONTRACTORS • DESIGNERS • MANUFACTURERS

## General Electric EM* Pumps . . .

# Move liquid metals with greater safety and continuity

### . . . OPERATE WITHOUT MOVING PARTS, SEALS, OR BEARINGS

General Electric electromagnetic pumps, first designed for radioactive and high-temperature systems, are now used in liquid metal laboratories and industrial processes where minimum leakage and continuous operation are important.

Now designed to pump liquid metals at temperatures up to 1500 degrees F and to move up to 10,000 gallons per minute with accurate control of flow, General Electric EM pumps can be used to move such metals as sodium, sodium potassium, lead, bismuth or mercury.

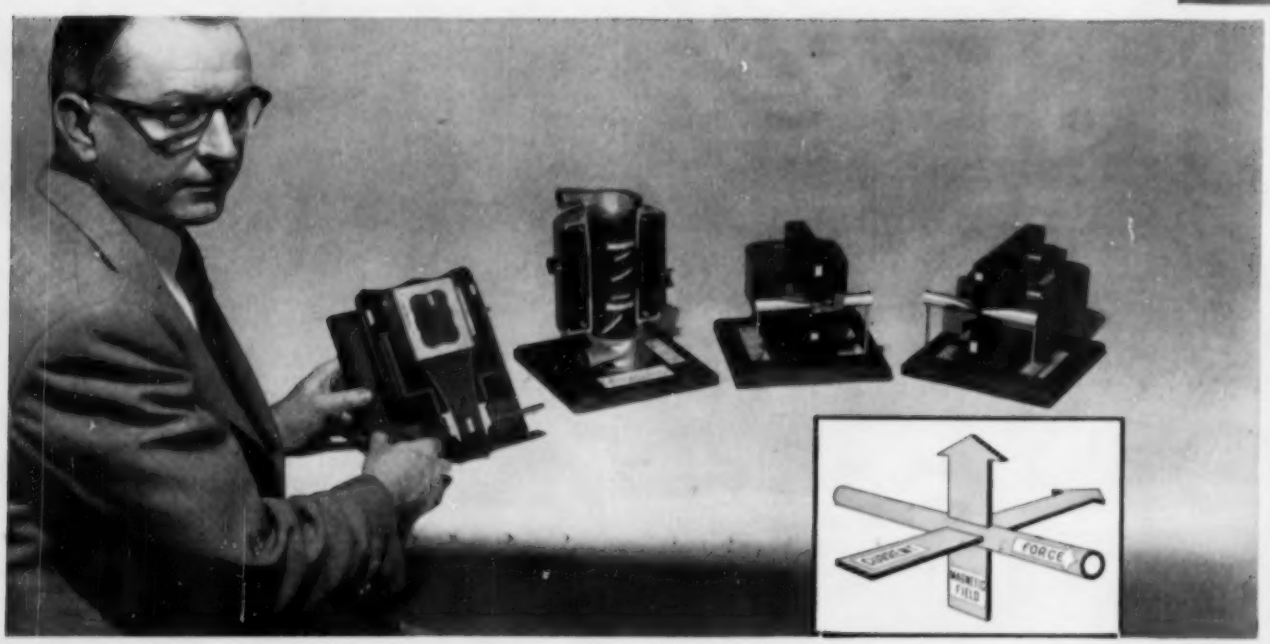
**Electromagnetic*

General Electric offers complete liquid metals pumping systems including EM pumps, magnetic flowmeters, liquid level indicators, pressure transmitters, induction heaters, cold traps, plugging indicators and sodium oxide control stations.

For more information on liquid metals pumping systems and components, contact your nearest G-E Apparatus Sales Office, or Section 193-1, General Electric Company, Schenectady 5, New York. Outside of the U.S. and Canada write to: International General Electric Company, 570 Lexington Avenue, New York City, N. Y.

*Progress Is Our Most Important Product*

**GENERAL ELECTRIC**




**FOUR GENERAL ELECTRIC EM PUMP MODELS are shown by J. F. Cage, Manager—Component and Coolant Systems Engineering Operation, Atomic Power Equipment Department, (l. to r.): linear induction, helical flow, d-c, and a-c types. Diagram shows pumps' operating principle: Force is exerted on current-carrying liquid in magnetic field.**

**LIQUID METAL LOOP** tests sodium potassium (NaK) in a G-E electromagnetic pumping system for use as heat-transfer agent. Loop's a-c EM pump (below) operates at 600 degrees F with capacity of 30 gallons per minute. Magnetic flowmeter (left of pump) measures flow externally, providing greater safety.



GENERAL ELECTRIC

# Johns-Manville organizes to give you better insulation service

*New and separate insulations division created to provide industry greatly improved Sales and Engineering service to meet modern problems*

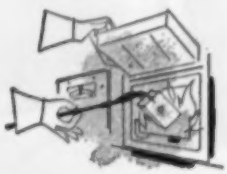
• Johns-Manville is now concentrating all industrial insulation operations within a new, fully integrated insulations division. This greater specialization makes possible the most complete insulation service available to industry. It consists of—

**Sales Representatives . . .** men on whom you can rely for your insulation recommendations. Your J-M salesman will help you select the insulating material exactly right for your job—the one that will provide maximum fuel savings, improved process control, and minimum maintenance. As co-ordinator of J-M's extensive research-engineering-manufacturing facilities, he offers you outstanding insulation training and experience.

**Insulation Engineers**—Backing up the J-M salesman on every job is the J-M insulation engineer. He is primarily concerned with solving insulation problems. He recommends the economic thickness of insulation, as well as the proper finishes, weatherproofing and securement. His highly specialized knowledge makes possible an intelligent recognition and handling of your individual insulation requirements.

**Insulation Contract Units . . .** Fully aware that no insulation is better than the man who applies it, the J-M Insulation Contractor makes care and skill in the scientific application of Johns-Manville insulations his stock in trade. He maintains a complete crew of estimators and mechanics trained in J-M application techniques. He is ready to give you fast, efficient service on any insulation job—large or small. Proud of his reputation for integrity in his own community, the J-M Insulation Contractor merits your complete confidence.

**Complete Range of Products**—In this day of exacting temperature control, the need for specific insulations for specific services is greater than ever before. Recognizing this, Johns-Manville manufactures insulations for every industrial requirement. Produced from the finest grades of asbestos, magnesium carbonate, diatomaceous silica, refractory clays and ceramic fibers, they are designed to afford maximum insulating effectiveness and durability at operating temperatures ranging from minus 300F to plus 3000F.



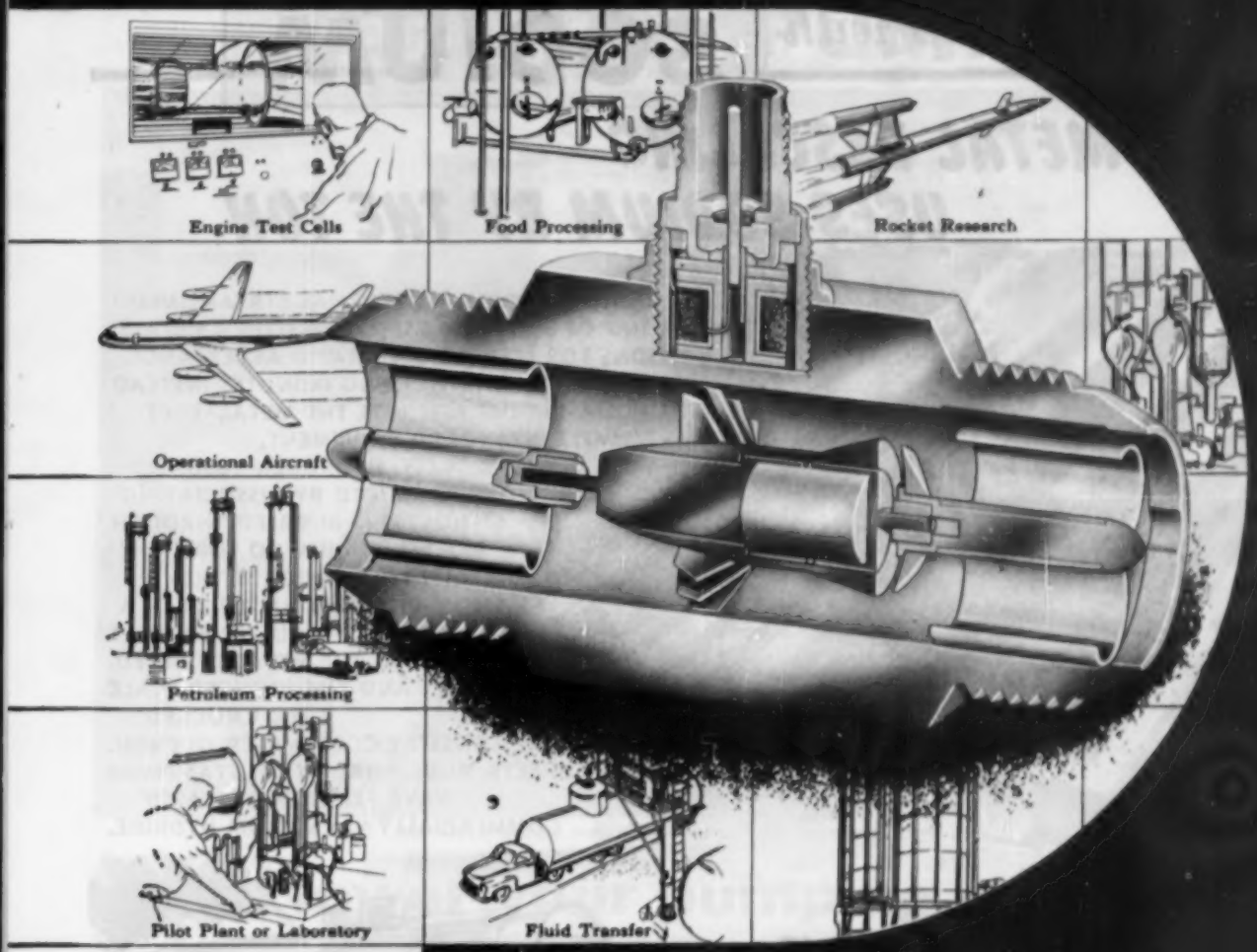
**Extensive Research Facilities**—At Manville, New Jersey, Johns-Manville maintains the world's most completely equipped insulation laboratory. Here insulation scientists are engaged in a continuous program of developing new and better insulating materials. In addition, their technical knowledge is always available to J-M customers whose insulation problems require special study.

**Experienced Management**—At headquarters as well as in the field, management of the new insulations division consists of men who, in line with J-M's promotion-from-within policy, are insulation veterans. With a realistic grasp of customers' needs, they are alert to new and better ways to serve you . . . now, and in the future.

**On Your Next Insulation Job**—Whether your next insulation job is big or little, simple or complex, let Johns-Manville handle it for you. Just call your nearest J-M sales office, or write direct to Johns-Manville, Box 14, New York 16, New York. In Canada, Port Credit, Ontario. *Chances are, you'll be glad you did!*

**Johns-Manville *first-in* INSULATION**

**MATERIALS · ENGINEERING · APPLICATION**




# POTTERMETERS

## *Complete flow control systems*

In every industry where liquid flow information is required, Pottermeters have set new standards of accuracy and reliability.

The only "bearingless" flow meter, the Pottermeter is unaffected by caustics, acids, corrosives and completely reliable even under extreme conditions of temperature and pressure.

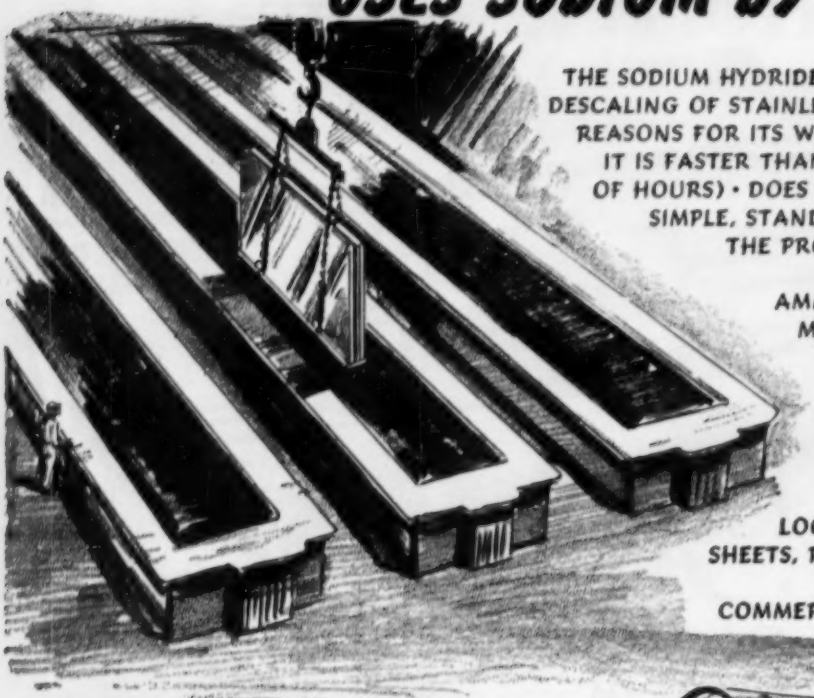
Potter engineering has solved many "impossible" flow control problems. Maybe we can help you.

**POTTER AERONAUTICAL COMPANY**

Route 22, Union, New Jersey

*keeping up with* **SODIUM**

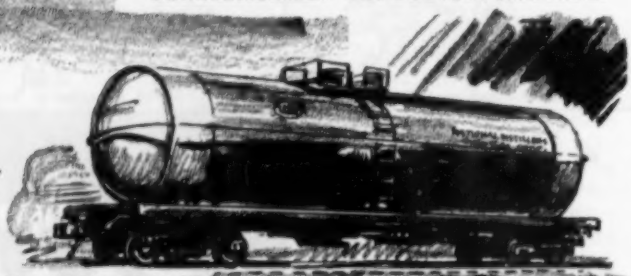
# METAL DESCALING USES SODIUM BY THE TON



THE SODIUM HYDRIDE PROCESS HAS STREAMLINED DESCALING OF STAINLESS STEEL AND OTHER METALS. REASONS FOR ITS WIDE AND RAPID ACCEPTANCE: IT IS FASTER THAN PICKLING (MINUTES INSTEAD OF HOURS) • DOES NOT BITE THE METAL • USES SIMPLE, STANDARD EQUIPMENT.

THE PROCESS: HYDROGEN (USUALLY PRODUCED BY DISSOCIATING AMMONIA) IS BUBBLED THROUGH MOLTEN SODIUM TO FORM THE HYDRIDE, WHICH IS THEN DISSOLVED UP TO 2% IN A CAUSTIC BATH AT 700°C. THE METAL IS DIPPED, AND THE REDUCED SCALE THEN KNOCKED LOOSE BY COLD WATER QUENCH. SHEETS, RODS, WIRE, STRIP, STAMPINGS HAVE ALL BEEN DESCALED COMMERCIALLY VIA SODIUM HYDRIDE.

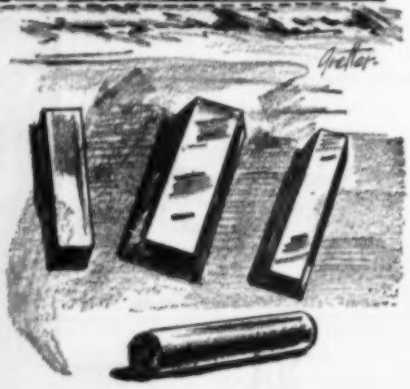
## SODIUM AS YOU LIKE IT



NO MATTER WHAT YOUR SODIUM APPLICATION—PLANT, PILOT OR LAB SCALE—U.S.I. MAKES THIS METAL AVAILABLE IN THE FORM AND SIZE YOU NEED.

THERE IS THE GIANT ECONOMY PACKAGE FOR BULK USERS—THE 40-TON TANK CAR OF SOLID MATERIAL. SODIUM IS ALSO PACKAGED CAST SOLID IN 55-GAL. STEEL DRUMS OR 5-GAL. STEEL PAILS.

THEN THERE ARE THE BRICK FORMS—IN 12, 5, 2½ AND 1-LB. SIZES—PACKED DRY IN 55-GAL. STEEL BARRELS. FOR SMALL USERS, 1-AND 2-LB. BRICKS CAN BE PURCHASED IN STEEL PAILS CONTAINING 20-LB. OF SODIUM. MORE DETAILS IN THE U.S.I. BOOK, "HANDLING METALLIC SODIUM ON A PLANT SCALE". WRITE FOR YOUR COPY.



## Metal Strength Through Sodium

SODIUM ADDED IN SMALL QUANTITIES (0.05%) TO ALUMINUM-SILICON CASTING ALLOY YIELDS REFINED GRAIN STRUCTURE, GIVING IMPROVED TENSILE STRENGTH AND ELONGATION. SODIUM HAS ALSO BEEN USED AS A DEOXIDIZER FOR BRASS AND COPPER AS WELL AS THE REFINING OF LEAD.

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Division of National Distillers Products Corporation
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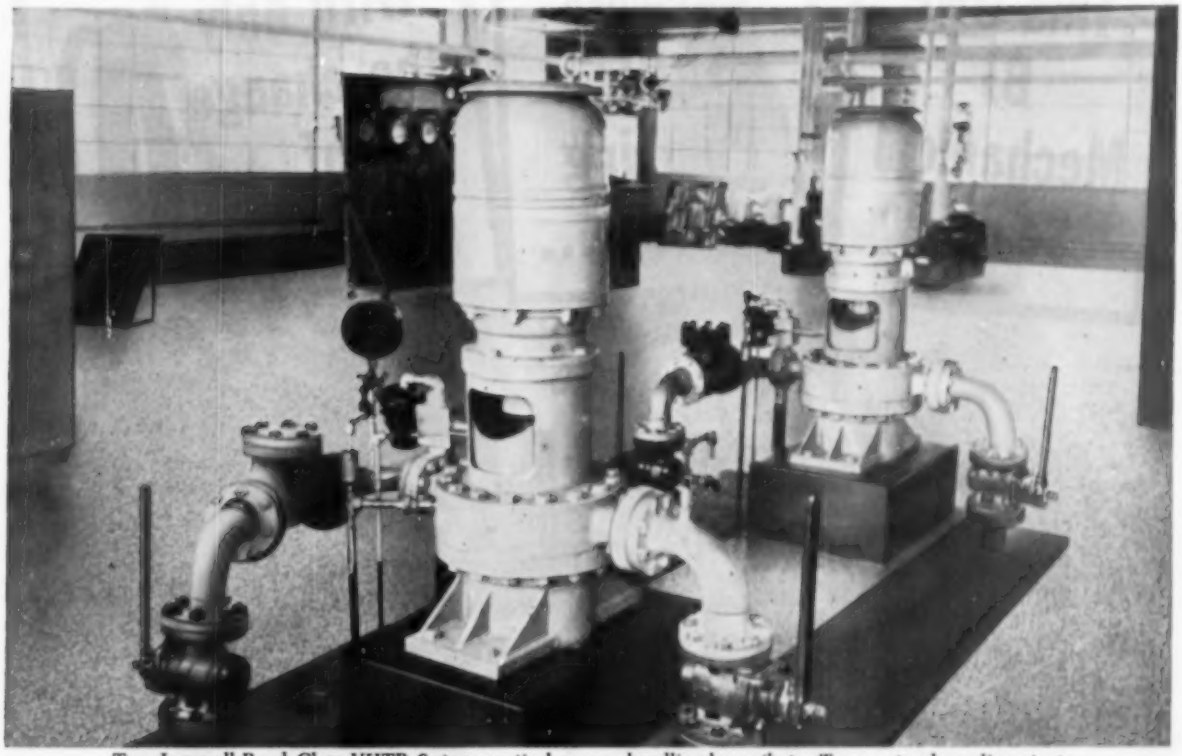
# VERTICAL PUMPS



Two Ingersoll-Rand Class VHTB 6-stage vertical pumps handling lean oil at a Texas natural gasoline plant.

## to lower your pumping costs

**CLASS VHTB**
**Pressures: to 1500 psi**
**Capacities: 25 to 325 gpm**
**Temperatures: to 750°F.**

Vertical, multi-stage diffusor-type unit. Single-suction impellers mounted back-to-back for axial hydraulic balance. Stuffing box under suction pressure.

For low capacities at high heads on process, boiler feed, hydraulic and similar applications.

**CLASS VP**
**Pressures: to 750 psi**
**Capacities: 10 to 350 gpm**
**Temperatures: to 750°F.**

Vertical, multi-stage, diffusor-type construction. Single-suction impellers with throttling sleeve balancing device to reduce axial thrust and provide suction pressure at stuffing box. Entire pumping element removable without disturbing suction and discharge piping.

For low capacities at medium high heads on applications such as process, boiler feed, and heater drain work.

Designed specifically for low-capacity high-head applications, these Ingersoll-Rand vertical process pumps are engineered with a background of process pump experience. They are manufactured in the most modern of pump plants to deliver years of efficient service with a minimum of down time and maintenance expense.

Features include: "Double-Case" construction with segmented diffusor-type inner casing for complete radial hydraulic balance and minimum bearing wear... Positive aligning feature for perfect positioning of inner casing segments... Rotor assembled without prestressing shaft to eliminate all possibility of shaft distortion. Available in bronze fitted, all iron, carbon steel, and stainless fitted materials to cover a wide range of process services.

Ask the Ingersoll-Rand engineer to show you these and other features which make Ingersoll-Rand pumps your best bet for low cost year-in, year-out service.

**Ingersoll-Rand**

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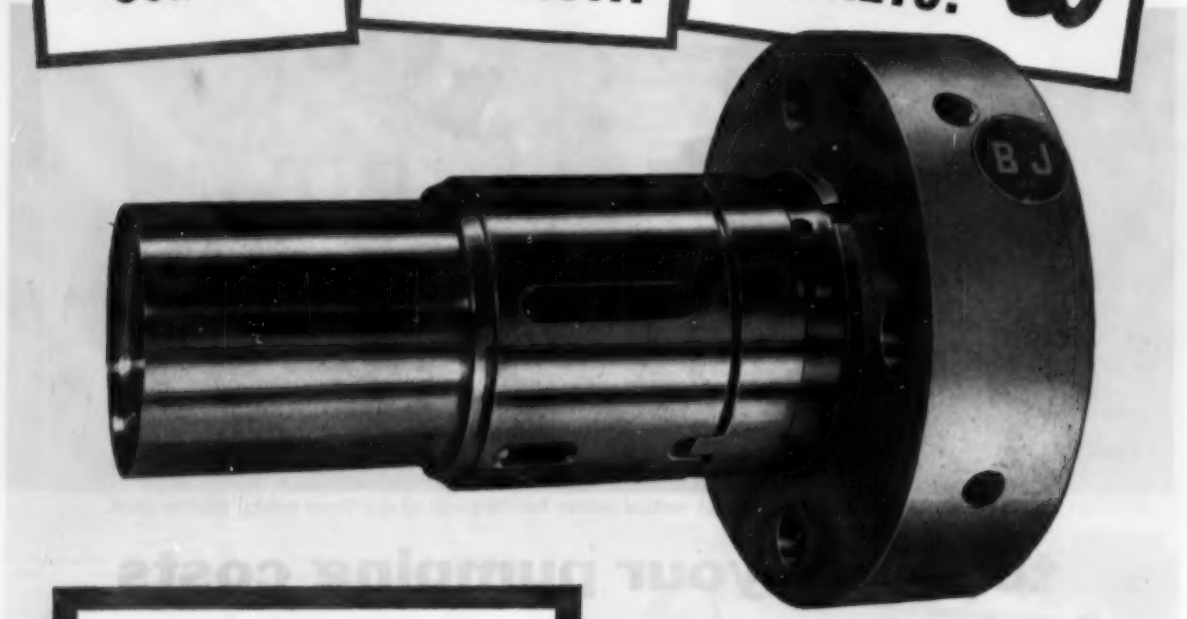
**COMPRESSORS · GAS & DIESEL ENGINES · AIR & ELECTRIC TOOLS · CONDENSERS · PUMPS · ROCK DRILLS · VACUUM EQUIPMENT**

# This ONE BJ Mechanical Seal...

# Answers THREE Pumping Services...

# With only the change of GASKETS!




**1 HIGH OR LOW TEMPERATURES**
The BJ *ASBESTOS* GASKETS handle temperatures from minus 100°F to plus 650°F.

**2 CORROSIVE**
The BJ *TEFLON* GASKETS answer a wide range of corrosive fluids.

**3 HIGH PRESSURE**
The BJ *RUBBER* GASKETS handle pressures to 1000 PSI . . . and any general service needs.

This *one* basic Byron Jackson Type U Mechanical Seal solves *three* major pumping services with only the change of two gaskets. You benefit because: (a) you can *standardize* on this basic BJ Type U Seal and thus greatly reduce your parts and inventory needs; (b) you can convert process pumps to changes of service with only the change of two gaskets; and (c) you *eliminate* costly, troublesome stuffingbox repacking and unnecessary pump downtime.

Only Byron Jackson . . . the leader in Mechanical Seals . . . offers this simplified interchangeability of service through a change of gaskets.

If your operations involve multiple pumps with variations in service requirements, look into this basic BJ Type U Seal. If your pumping needs are more highly specialized in any one field, there's a BJ Mechanical Seal engineered to solve almost every stuffingbox requirement.

**FREE MECHANICAL SEAL SELECTION PORTFOLIO**—Send for this special Byron Jackson Mechanical Seal Selection Portfolio. Includes size, material, price and installation information. Write today to:

**Byron Jackson Pumps**
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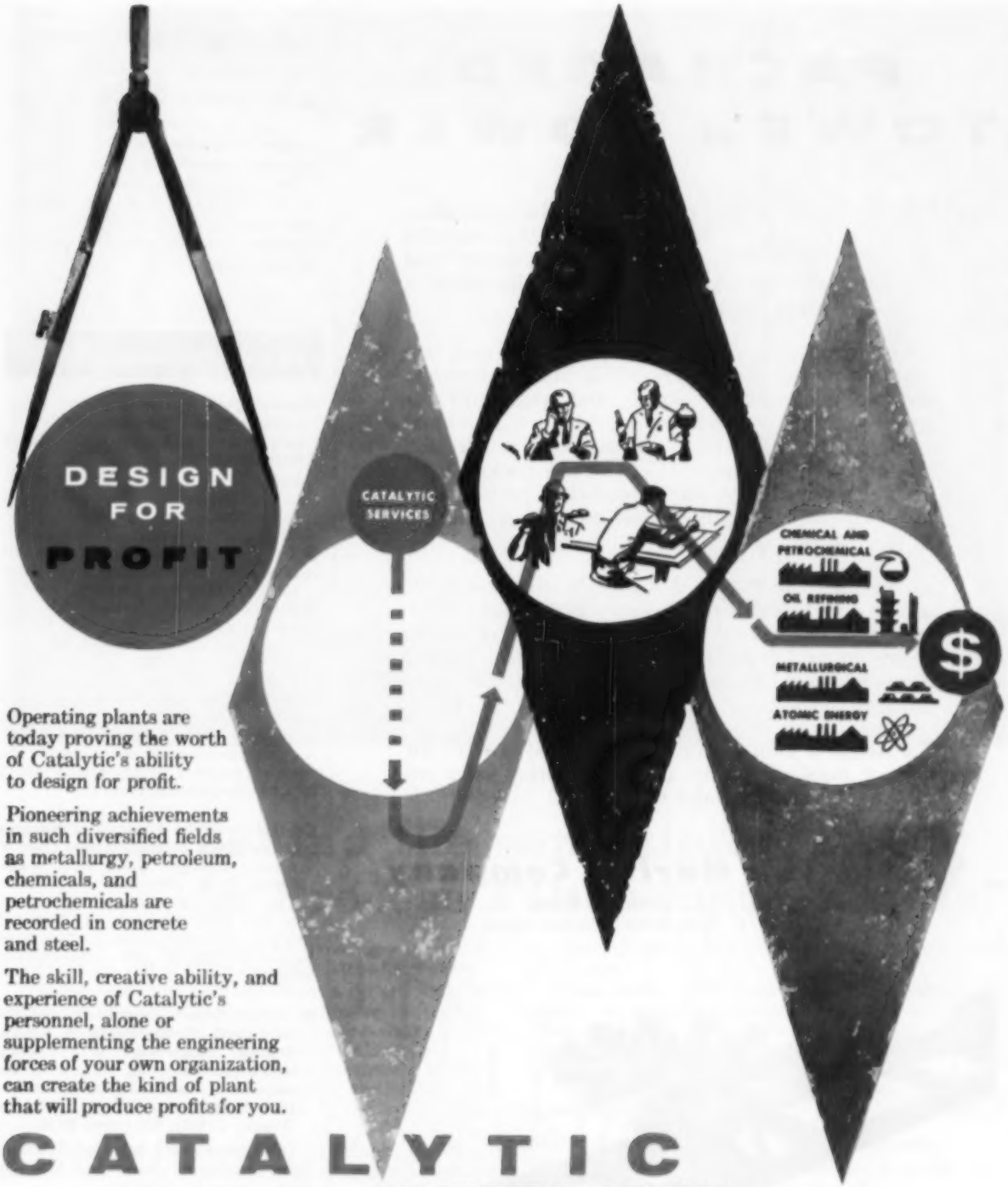
A Subsidiary of Borg-Warner Corporation
P.O. Box 2017A, Terminal Annex
Los Angeles 54, California

BJ

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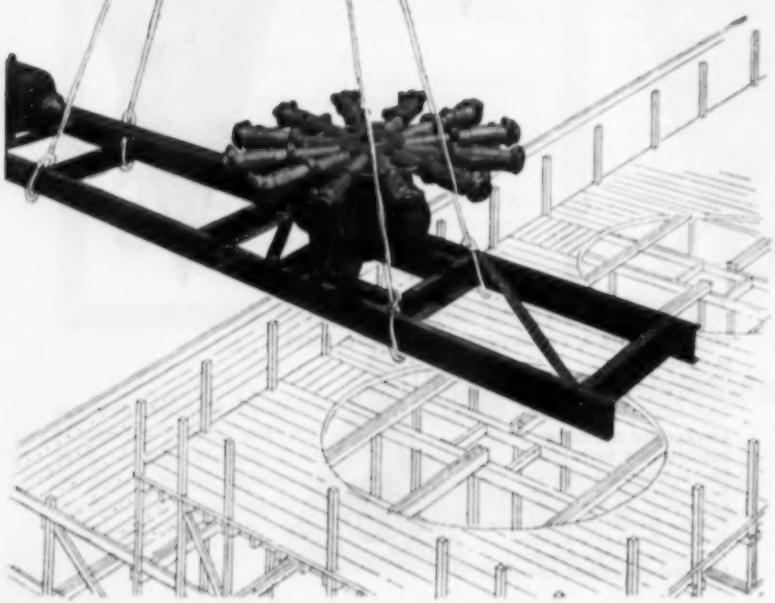


## Marginal notes

(*Continued from page* 18)

everyday problems. However, the book should prove valuable to the practicing engineer or graduate student interested in reactor engineering.

The editor and authors are to be commended for providing a valuable contribution to a field which is slowly in transition from an art to a practical applied science.

## Books received

**Peaceful Uses of Atomic Energy. Proceedings of the International Conference in Geneva, August, 1955. United Nations. (1956).**

Vol. 7, "Nuclear Chemistry and Effects of Irradiation," 694 pages, $10 (U.S.). Difficult problems in the development and operation of reactors—all chemical in character. The fundamental chemistry of various special materials.

Vol. 8, "Production Technology of the Materials Used for Nuclear Energy," 630 pages, $10 (U.S.). Details of chemical and metallurgical processes for uranium, thorium, beryllium, zirconium, etc.

Vol. 9, "Reactor Technology and Chemical Processing," 774 pages, $10 (U.S.). Papers and discussions on the fabrication of fuel elements, the chemical reprocessing of spent fuels, the chemical recovery of new fuel produced in a breeder reactor, etc.

**Conference of the Academy of Sciences of the USSR on the Peaceful Uses of Atomic Energy. U.S.A.E.C., Washington, D. C. (1956).**

The following sessions were held July 1-5, 1955; Divisions of Technical Science; Chemical Science; Biological Science; Physical and Mathematical Sciences.

**A Forum Report, Commercial and International Developments in Atomic Energy. Proceedings of a meeting held September 27-29, 1955, under the auspices of Atomic Industrial Forum, Inc., New York. Edited by Edwin Wiggin. (1956), 598 pages, $8.50.**

Discussions were held on Reactors; Reactor Safety; Radiation and Radioisotopes, Geneva Conference.

**Developments in Stainless-Steel Welding in the Nuclear Program. A Monograph by E. B. LaVelle, L. H. Rasmussen, and E. M. Kuchera. Technical Information Service, Atomic Energy Commission, Washington 25, D. C. (1956), 20 pages, 20 cents.**

This pamphlet describes an improved method for fabrication by welding which has been developed in connection with the nuclear program.

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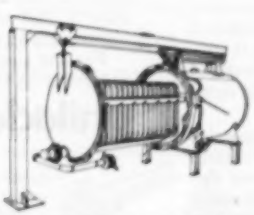
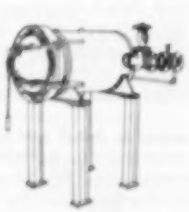

HORIZONTAL LEAF FILTERS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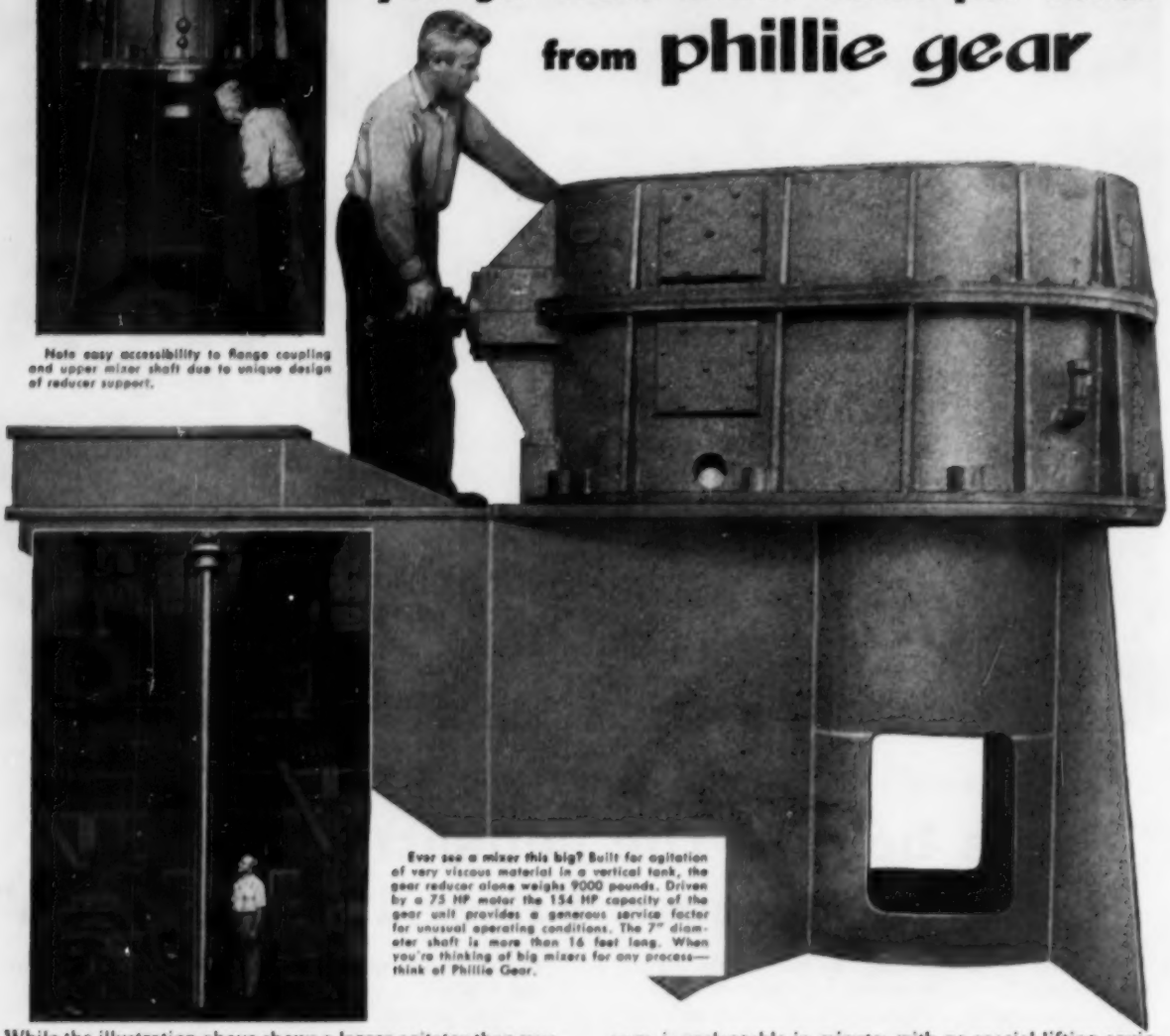



Ever see a mixer this big? Built for agitation of very viscous material in a vertical tank, the gear reducer alone weighs 9000 pounds. Driven by a 75 HP motor the 154 HP capacity of the gear unit provides a generous service factor for unusual operating conditions. The 7" diameter shaft is more than 16 feet long. When you're thinking of big mixers for any process—think of Phillie Gear.

While the illustration above shows a larger agitator than you may ever require . . . for any fluid mixing job, any process condition, or any kind of mixing, doesn't it stand to reason that a heavier, more powerful, better designed mixer will do more work for you, dollar for dollar, at less cost?

**Here's how, size for size, unit for unit, Philadelphia Mixers give you more mixer value per dollar invested.**

***(1) Philadelphia offers more horsepower capacity per dollar:*** All reducer drives are designed and built with generous service factors for long, quiet, trouble-free operation.

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## Noted and quoted

**SECRECY:**

### PROS AND CONS

**Quoted are two views. One is that of Berkner, who endeavors to speak for scientists. The other is that of the Citizens (McKinney) Panel, which considered secrecy and information control in an over-all study made for the Joint Committee on Atomic Energy.**

#### Secrecy and Scientific Progress

Serious technological secrecy is relatively recent, having emerged sharply as a product of the upsurgence of our technological revolution. There are, of course, a few earlier examples extending throughout history, but they were almost insignificant. But as society generally has become deeply dependent on technological development, so too have the military organizations increased their dependence on science and technology. Initially, at least, it appeared reasonable that the military should restrict the exchange of ideas having military implications on the ground that to permit the free flow of information would hand the enemy our developmental achievements "on a platter."

In the modern world, however, all the important areas of science have military implications and, under our present policies, must therefore fall inevitably under the cloak of military secrecy. . . Since more and more of our scientific activity is coming within the purview of secrecy, the need for appraisal of the effects of secrecy on our scientific stature and progress, and therefore on our national security, becomes of increasing importance. It seems highly probable that a little technological secrecy, like a little poison, may be a good thing, but too much can destroy us. Therefore, it is important to understand just where the balance lies.

. . . .

In the same way it is necessary to understand how the benefits of science to our nation will quickly be extinguished by widespread technological secrecy. In suppressing seemingly isolated scientific bits of information of direct military value, we prevent, at the same time, the germination of scientific ideas of much greater scientific, social, and military significance. The great concepts generated from a free and virile science and injected into our industrial complex can provide far greater security through technological supremacy than we could ever hope to achieve through the classification of technological information.

. . . .

The maintenance of the widespread secrecy of technological information makes necessary the employment of procedures and regulations for the security of such information. Under these procedures, the scientist cannot avoid becoming the almost unique target, for he is the source of much of the information that is to be protected. It is his creative thought that produces the need for technological secrecy. Yet the application of our present security procedures conditions the scientist to avoid contact with any idea that may lead to military application. Why should this be true? The reasons seem clear.

1. If the scientist knows no "secrets," he cannot be involved in security questions . . .

2 Clearance is not a permanent status, and a scientist's reputation is constantly susceptible to multiple jeopardy.

3. In the process of reassociating ideas in new ways, the scientist must acquire from many sources the ideas to be associated . . .

*(Continued on page 36)*

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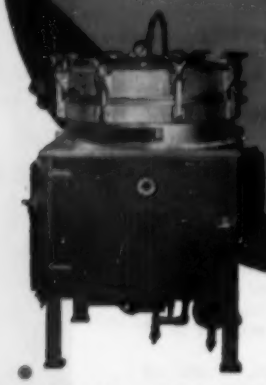

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## Noted and quoted

(*Continued from page* 34)

4. If a scientist has been engaged in scientific leadership in the national interest, he is inevitably involved in extensive security questioning relating to his colleagues, to the views of his colleagues, to his estimate of their intent, and to their statements and actions at informal scientific conferences . . .

5. If a scientist expresses a strong view on some technological matter that may be contrary to the application of technology to current or to subsequent policy, he is open to the accusation of taking this view with the intent of deliberate subversion . . .

6. In a system of widespread technological secrecy, the scientist finds it increasingly difficult to sort out from the tremendous multiplicity of facts those that are secret and those that are open . . .

7. The clearance procedure itself is complicated . . . .

The situations that I cite are not hypothetical; each one can be documented by specific cases. The point is that the security process strongly conditions the scientist *not* to do those very things that most need to be done to preserve the technological supremacy of our country. Under these circumstances, we have lost the spontaneous will and opportunity for men to contribute to our strength when they possess special knowledge and the vision to see how it can be applied. Responsible men recognize the conditioning and will not consciously permit it to stand in the way of their duty and responsibility to their country and to the ideals that it represents.

. . . .

Therefore, technological secrecy tends to put many of our best thinkers behind a wall across which they have no communication with our Government. Moreover, this wall excludes many of the great foreign scientists of our time. . . It is imperative that we find the best balance of technological secrecy as weighed against free information—a balance designed to give us optimum strength.

. . . .

A deep and searching inquiry into the restrictions on technological information is needed to determine where the public interest really lies. Such an inquiry . . . would define the kinds of technological information that should be kept secret and outline procedures for its selection and protection. It would require the exercise of judgment in balancing all of the factors required by the national interest and security in deciding when information should be classified. It would provide for peri-

(*Continued on page* 42)

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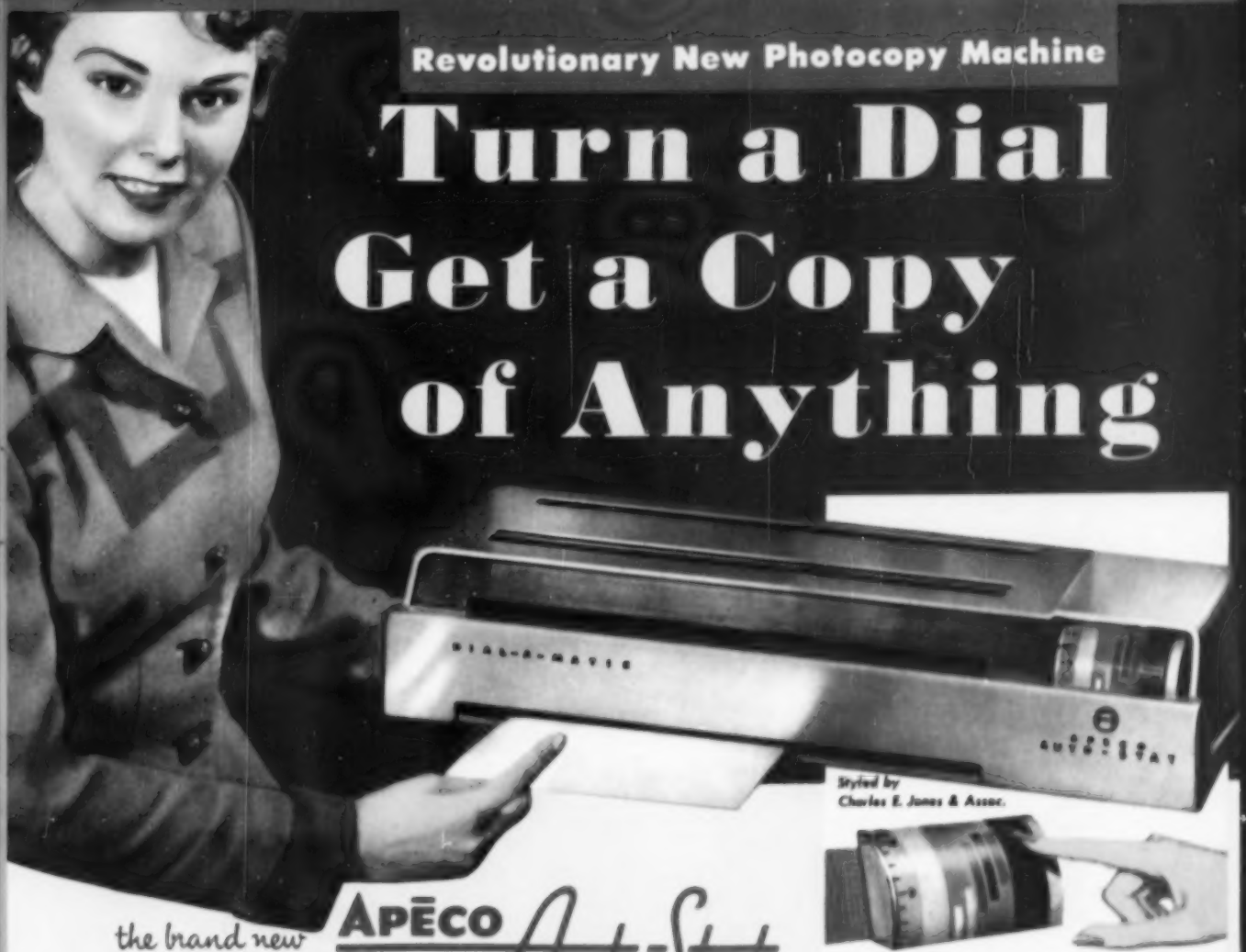

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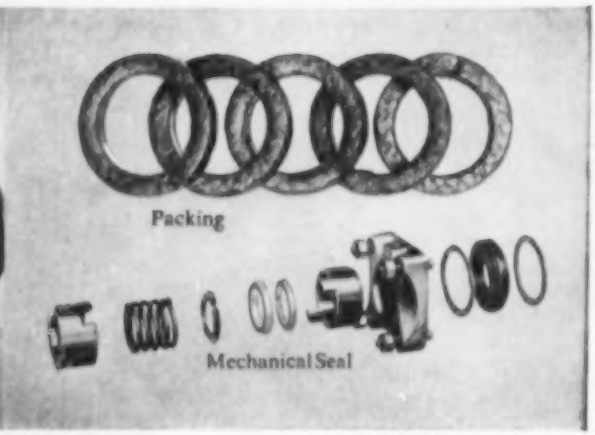
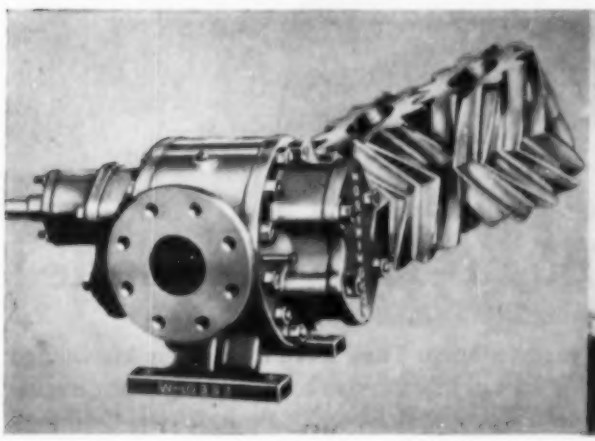



**Pump standardization—how do you benefit?** By standardizing, you can often drastically cut your spare parts inventory. With Worthington's SESC (Standard End Suction Centrifugal) line, you are also assured of immediate delivery from factory or distributor stocks. Because the SESC line consists of standardized "parts" not "pumps," it can be built in many different combinations . . . 70,480 to be exact. For all these reasons, more and more companies are turning to SESC pumps. See bulletin W-300-B4.

**Packed stuffing box or mechanical seal—which is preferred?** Each has its applications. Mechanical seals are gaining in popularity year after year. With Worthington's Standard End Suction Centrifugal pumps you not only get your choice of mechanical seals—or packing—but you can easily convert from one to the other using standard stock parts. This "interchangeability" is just one of the many extra advantages of Worthington's SESC line. For more details write for bulletins W-300-B4 and W-350-B16.



**Which pump is best for difficult suction conditions?** Worthington's close-clearance rotary pump is self-priming and can operate under vacuums as high as 28 inches of mercury. The large unobstructed suction opening in this herringbone gear pump permits operation with thin or viscous liquids at high efficiency. The double-helical gears balance all end thrust, eliminate trapping of liquid between gear teeth and provide a quiet, pulsation-free flow at high speeds. For the full story, ask for bulletin W-483-B2.

**Whose pumps would you expect to find in the Eiffel Tower?** If you said "Worthington's," your P.Q. is all right. The original steam-driven pumps that power the Eiffel Tower's 100-passenger hydraulic elevators were built by Worthington back in 1889. The most recent additions, modern electric-drive Worthington pumps, moved into the Tower just last year. Today as then, wherever men must move liquid, they turn to the company with a reputation for performance. Worthington Corp., Harrison, N. J.

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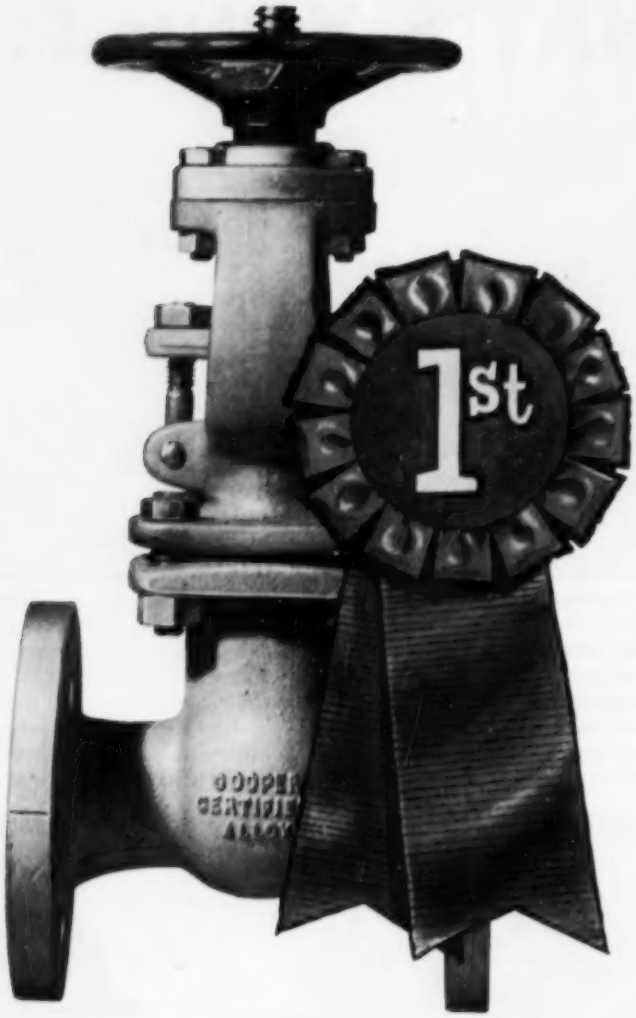


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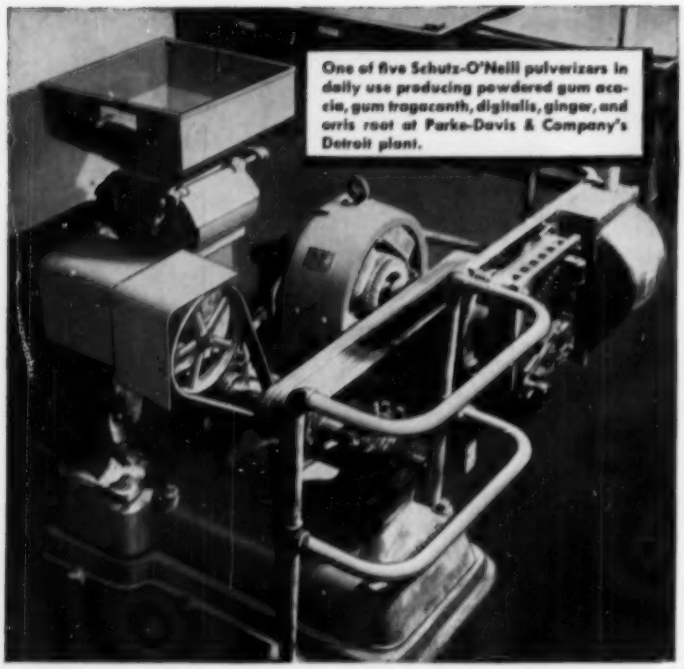


One of five Schutz-O'Neill pulverizers in daily use producing powdered gum acacia, gum tragacanth, digitalis, ginger, and orris root at Parke-Davis & Company's Detroit plant.

# SCHUTZ-O'NEILL PULVERIZERS

## A 50-YEAR TRADITION

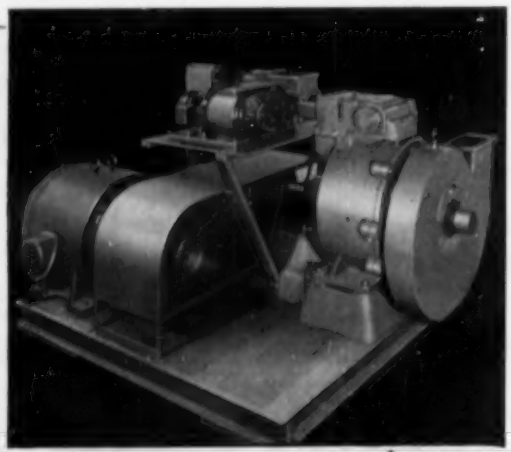
The name Parke-Davis & Company is known worldwide as a leading pharmaceutical manufacturer. For over fifty years Schutz-O'Neill pulverizers have played a dominant part in this well earned reputation in the production of highest quality products that meet the most rigid standards.

Manufacturers of food, chemical, drug and mineral products have depended on Schutz-O'Neill pulverizers for over 65 years. In all parts of the world Schutz-O'Neill pulverizers are in daily operation preparing materials ranging from microfine powdered sugar in the food industries, to borax in the mineral industries.

Versatility for production of medium-coarse, fine and microfine powders have made them the choice for milling superior powders from such materials as specialty grain fractions, cocoa powder, aspirin, saccharin, ultrafine diatomaceous earth, limestones and phosphates, urea melamine and phenolic plastic moulding powders, and herbs, barks, roots and seeds of all types.

**One of six new SCHUTZ-O'NEILL SUPERFINE PULVERIZERS**

now available in sizes ranging from 7½ to 125 horsepower with grinding chambers 12" to 28" in diameter.



**SEND SCHUTZ-O'NEILL YOUR SIZE REDUCTION PROBLEMS**

Our engineers will welcome working with you on your new product or help improve the milling operation of your present products. Give us your requirements and send a sample of feed material for a pilot plant test. There is no obligation.

ESTABLISHED 1893

**SCHUTZ-O'NEILL COMPANY**

339 PORTLAND AVENUE, MINNEAPOLIS, MINNESOTA

PULVERIZERS
GRANULATORS
ROLLER MILLS
AIR CLASSIFIERS
SIFTERS
HAMMERMILLS


## Noted and quoted

(*Continued from page 36*)

odic review of classified information and its quick release when appropriate.

*Lloyd V. Berkner*
in *Science*

**This article is based on Dr. Berkner's statement to the Government Information Subcommittee of the Committee on Government Operations, House of Representatives.**

---

### Secrecy and Control of Information

. . . The right of the Government to control information in the interest of national security is constitutional. There is general agreement that secrecy and classification are necessary parts in the maintenance of the national defense posture.

There are two systems now in force for the control of information relating to national security. The most widespread system is that employed with regard to *defense information* which is administered under an Executive order. A narrower area involves information categorized as *restricted data*. The A.E.C. has complete authority to determine what information falls within this category and only the Commission can take steps to remove material from this category. The Commission has defined entire broad areas of information relating to atomic energy to be restricted data. Newly developed facts in these areas are "born classified." Such facts can be made available only to properly authorized persons; such authorization for access is controlled completely by the Commission.

The Atomic Energy Act of 1954 urges the Commission to take such steps as it can, without undue damage to national security, to allow atomic-energy information to be available to as many people as possible. For the accomplishment of this, the law encourages prompt declassification and authorizes the establishment of categories of sensitivity of data together with parallel categories of clearance for individuals.

The Commission reports that it is instituting procedures to speed review of an increasingly large volume of atomic technology related to peaceful uses. In addition, the Commission has established a system of access permits which can be granted to individuals with less complete investigation than required for access to highly sensitive information. . . . The Commission reports that the

(*Continued on page 50*)

EXTRUSION PRESS
MORGANTON, N. C., PLANT

AS PARTNERS IN
YOUR PROGRESS . . .

OUR MANUFACTURING SKILL
– is a *plus* factor!

Each process stage in the manufacture of electrodes, anodes, mold stock and carbon brick must be skillfully engineered to obtain the particular end-use chemical and physical properties desired.

The advanced handling techniques and quality control safeguards developed by our engineers and technicians give customers an important *plus factor* in the reliability of GLC carbon and graphite products.

The high degree of integration between discoveries in our research laboratories, refinements in processing raw materials, and improved manufacturing methods is further assurance of excellent product performance.

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DIVISION

Great Lakes Carbon Corporation

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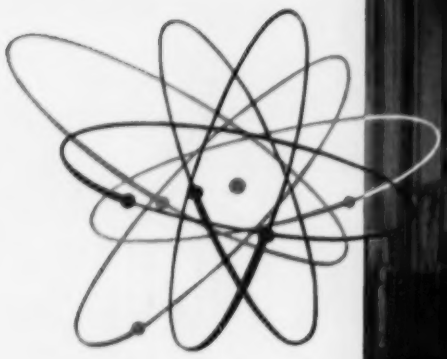
See this Crane valve design at the 1956 Atomic Industry Trade Fair, Navy Pier, Chicago, Sept. 24 through 28. Booths 336-337.



Eight Crane all-stainless parallel disc gate valves—similar to this one, but with butt-welding ends—will be on main coolant lines in new prototype atomic power reactor plant.

# AGAIN... Crane leads the way in flow control for atomic power

As the age of atomic power unfolds and expands, Crane continues to lead the way in flow control.

Crane equipment is already playing an important role in the mighty *Nautilus* and *Seawolf*—the Navy's celebrated atomic-powered submarines.

Now Crane valves are ready to make history again in the peaceful use of atomic energy—in the nation's first land-based atomic power plant.

Eight Crane stainless steel gate valves—similar to the one shown above—will be on the main coolant lines in the pressurized water reactor. Crane's broad experience in flow control for atomic power—dating from the beginning of this radically different field—assures low-cost, dependable service on this critical application.

Whether your future involves atomic energy for power or radioactive materials for processing—call on Crane for the right valves and fittings. You'll find Crane has the depth in research, engineering, and manufacturing abilities and facilities you're looking for.

**CRANE** VALVES & FITTINGS

PIPE • KITCHENS • PLUMBING • HEATING

*Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas*

SPARKLER
horizontal plate
FILTERS

# Undisputed First Choice

with engineers who have had occasion to thoroughly test this type of filter. Shown here are structural features that are the result of over 30 years experience in building this one filter. If it could be made better or cheaper Sparkler would have made it that way long ago.

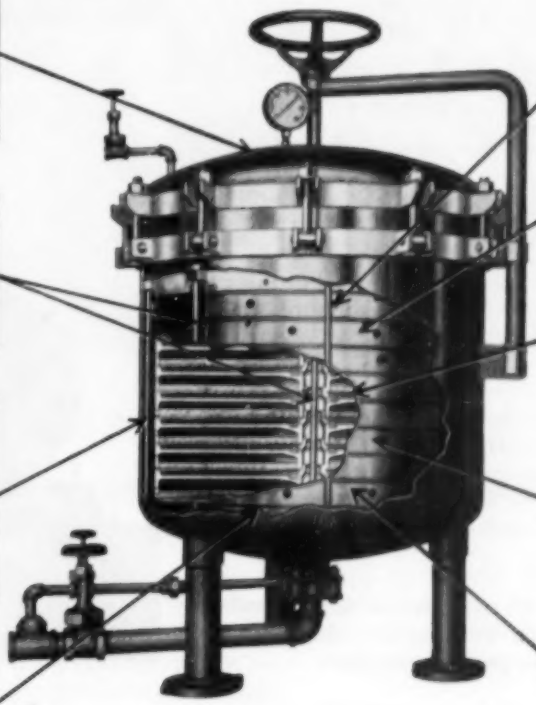
Aloysius C. Kracklauer
Originator of the Horizontal Plate Filter

A.S.M.E. designed construction is standard for pressures up to 60 lbs. on all filter tanks.

Plates sealed independently at center and periphery to assure positive seal.

Plates sealed independent of tank closure to secure a positive seal for both filter plates and for tank cover.

Scavenger plate supported by re-inforced flat bottom tank.



Cartridge plate assembly—removable independently of tank.

Heavy solid plate rings precision machined.

Heavy perforated sheet metal support for filter paper.

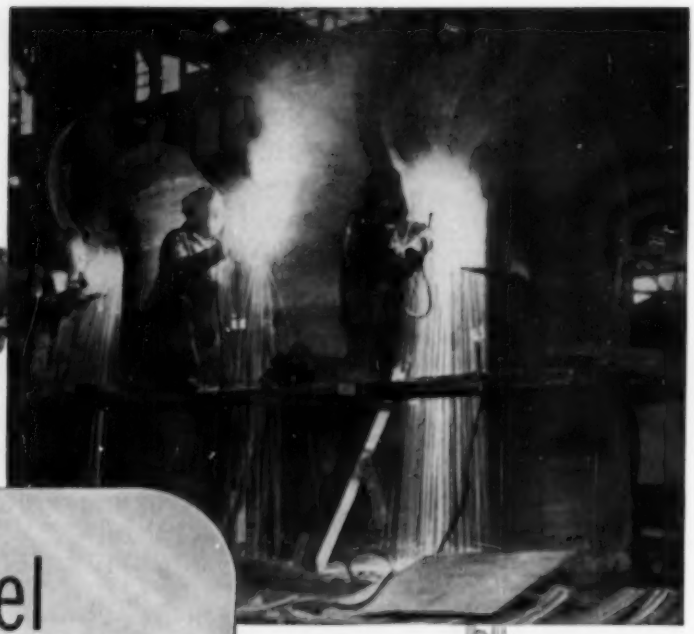
A more positive filter seal is obtained when hydraulic pressure is applied to plates externally rather than internally.

Plate designed to reduce flow friction to a minimum.

The Sparkler, original exclusive horizontal plate design and flow principle, has never been equalled for efficiency and dependability in filtering with any and all types of filter aids. The cake maintains its original position as formed regardless of pressure fluctuation flow rate or viscosity. No break-through is possible, even with a complete shut down of the filter. Filtering can be resumed with perfect safety at any time. With Sparkler plate construction a completely sanitary filter can be furnished.

SPARKLER FILTERS

**SPARKLER MANUFACTURING CO.** MUNDELEIN, ILLINOIS
*Sparkler International Ltd.—Manufacturing plants in Canada, Holland, Italy and Australia.*
REPRESENTATIVES IN PRINCIPAL CITIES THROUGHOUT THE WORLD



# stainless steel holds the answers

Every industry that works with steel has its special problems of the proper steels for every job . . . more and more industries are finding that Stainless "holds the answers" to their problems.

Take the petroleum and chemical industries for instance. They demand resistance to corrosion, to abrasion, high temperatures, cold temperatures, scaling and hydrogen blistering. Solid stainless can do the job. But, in some equipment, stainless cladding can answer the problems . . . and cut costs as well.

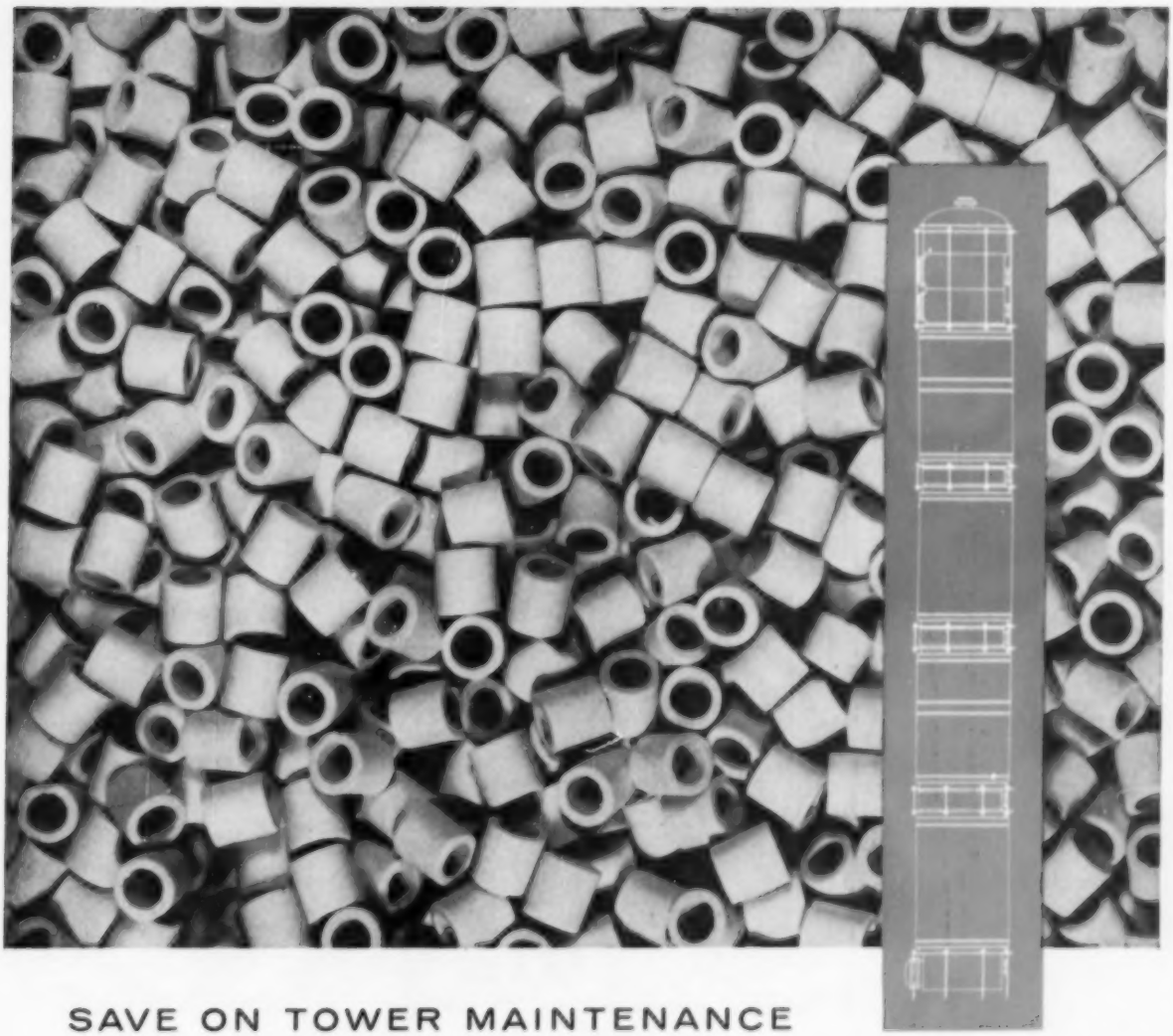
Sun Ship knows how to fabricate stainless and the other special alloys. They have the facilities and experience. Large jobs or small jobs will receive prompt attention.

*Our Sales Engineering Department will be glad to discuss with you any problems to which our Alloy Products Shop may hold the efficient and economical answer.*

**ALLOY PRODUCTS SHOP**

**OF Sun SHIPBUILDING & DRY DOCK COMPANY**

**ON THE DELAWARE • CHESTER, PA.**



SAVE ON TOWER MAINTENANCE

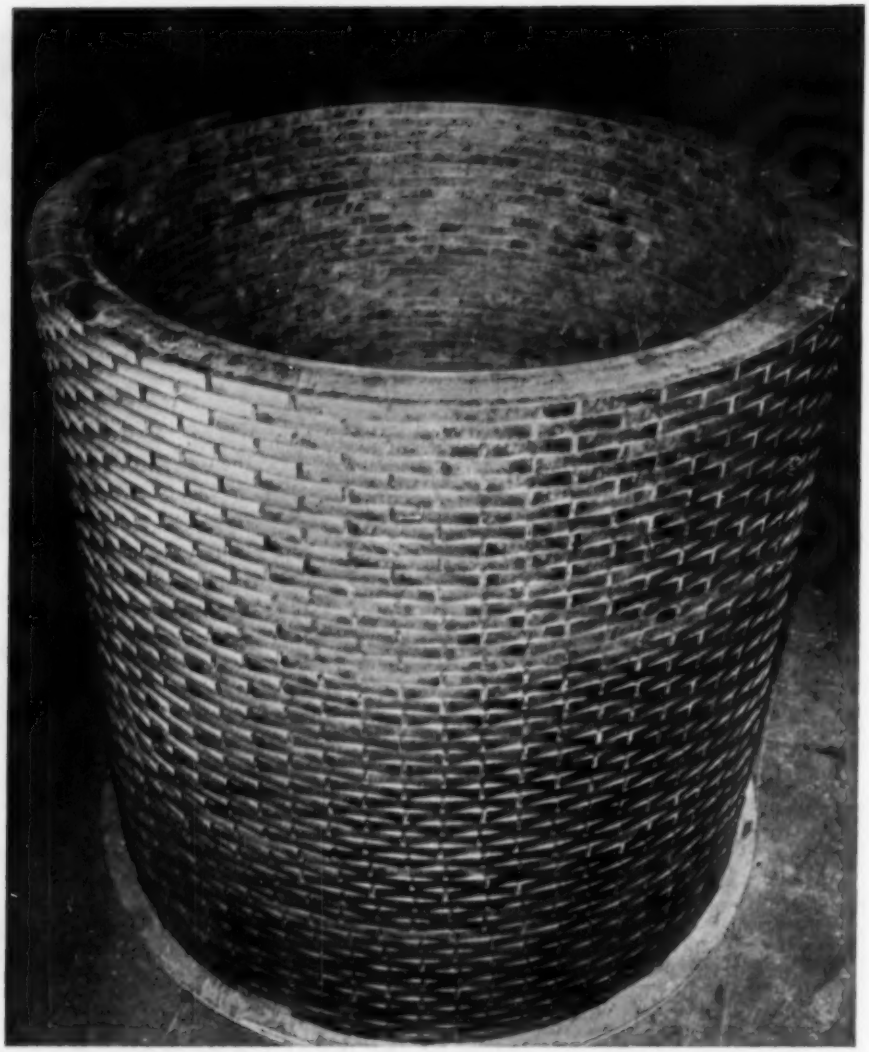
## PACK WITH LAPP PORCELAIN RASCHIG RINGS

Lapp raschig rings are smooth, completely vitrified, strictly non-porous and iron free. They are chemically inert to acids of all concentrations (except hydrofluoric); there can be no crumbling from capillary pressures nor absorption of liquids to contaminate later processing. This combination of characteristics assures an indefinite life chemically. Physically, Lapp raschig rings are tougher against damage from handling and tower operation than other ceramic rings or other packing shapes.

Lapp customers report longer continuous service and greater purity of product from their Lapp packed towers . . . with greatly reduced maintenance costs.

*WRITE for our bulletin describing the characteristics of Lapp Chemical Porcelain. See how you can save with a trouble-free system of Lapp Porcelain. Lapp Insulator Co., Inc., Process Equipment Division, 836 Wendell St., Le Roy, New York.*

**Lapp**
**CHEMICAL**
**PORCELAIN**



# First "service" station for submarine reactors ...transition shield of LEAD brick

Here's something new in the swiftly advancing technology of atomic power . . . a chamber devised for recharging reactors of submarines . . . and maybe, someday, reactors of ships, planes, locomotives and stationary power plants. Here, shielded by lead, men can service equipment safely.

The specially designed bricks were produced by National Lead. They stack and fit perfectly, in a circle . . . without mortar. Inner surfaces are contoured to the chamber arc. Interfaces are also curved . . . to mate and mesh in a structurally sound configuration. Nowhere does a crack offer a straight-line path for radiation.

Maybe you need lead brick . . . extruded, curved "Protecto" brick . . . or conventional, flat-sided extruded brick. Maybe you want lead in some other standard form . . . sheet, slab or sleeving, for instance. Maybe you want some specially built shape.

You can get lead shielding the way you want it from National Lead. Just call the nearest branch.

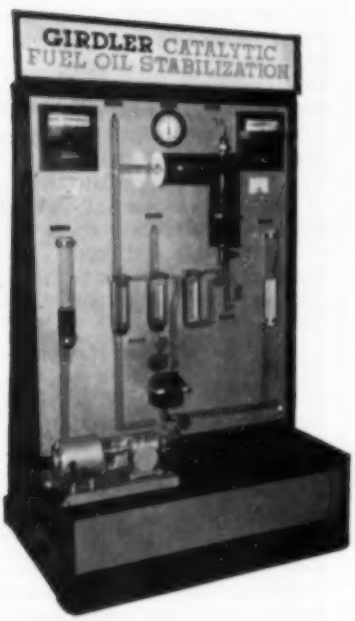
## National Lead Shielding

**NATIONAL LEAD COMPANY,** New York 6; Atlanta; Baltimore 3; Buffalo (Depew P. O.); Chicago 80; Cincinnati 3; Cleveland 13; Dallas 2; Philadelphia 25; Pittsburgh 12; St. Louis 1; Boston 6 (National Lead Co. of Mass.); Los Angeles 23 (Morris P. Kirk & Son, Inc.); Toronto, Canada (Canada Metal Company, Ltd.).

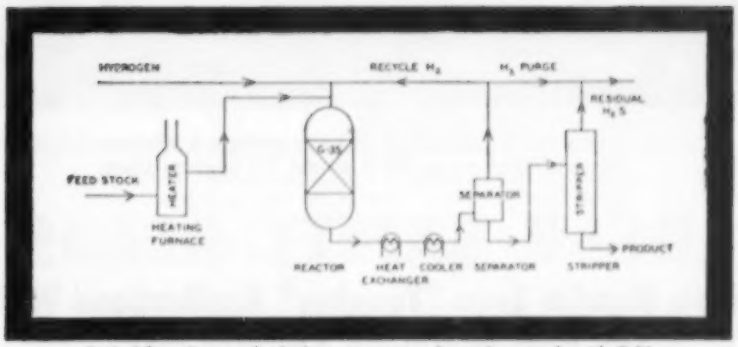
# NEW GIRDLER CATALYSTS

# G-35

commercially proven for upgrading petroleum stocks by hydrogen treating




A unit for demonstrating the performance of Girdler G-35 Catalysts on customer feed stocks.




Typical flow diagram for hydrogen treating of petroleum stocks with G-35.

● Naphthas, middle distillates, and gas oils can all be upgraded by hydrogen treating with the use of new Girdler G-35 Catalysts. These highly active cobalt molybdenum catalysts were developed specifically for the desulfurization, denitrification and stabilization of petroleum feed stocks covering a wide molecular range.

Improvement of color, stability, octane rating and burning characteristics and the removal of poisons for catalytic reforming are among the important results achieved.

Girdler G-35 Catalysts feature outstanding physical properties which are retained—even after repeated regenerations and use. Permit outstanding operational flexibility, continuous economical operation with essentially 100% yields.

For detailed information on the new G-35 Catalysts, simply write The Girdler Catalyst Department.

CATALYST DEPARTMENT

**The GIRDLER Company**

A DIVISION OF NATIONAL CYLINDER GAS COMPANY
LOUISVILLE 1, KENTUCKY

Safety for an aircraft test facility at Pratt & Whitney Aircraft Plant, using BS&B Model DV Rupture Discs.

# BS&B SAFETY HEADS

## Now Handle Even "Tougher" Applications With The New Model DV Rupture Disc . . .

**FEATURES OF THE MODEL DV DISC**

- ✔ Unrestricted, Instantaneous Opening In Sizes 1" Through 36".
- ✔ Greater Safety — Operates Closer To Disc Rupture Pressure.
- ✔ Minimizes Metal Creep Due To Elevated Temperatures And Pressures.
- ✔ Pressure Ratings: 5 lbs. To Several Hundred Pounds.
- ✔ Temperature Ranges: Sub-Zero To 900° F.

- **High Temperature**
- **Alternating Pressure and Vacuum**
- **Cycling**
- **Corrosive Service**

**USE BS&B SAFETY HEADS!**

Utilize Our Research Facilities In Selecting Model DV Discs For "Tough" Applications.

**BLACK, SIVALLS & BRYSON, INC.**

Safety Head Division, Dept. 2-DX9
7500 East 12th Street Kansas City 26, Missouri

## Noted and quoted

(*Continued from page 42*)

slowness of implementation is not a serious barrier to prompt development of peaceful uses because most of the information needed by industry has already been either declassified or designated as declassifiable. Industry representatives counter that information designated as "declassifiable" is still not readily available and that additional information is presumed by industry to lie within those areas still highly classified because of their connection with military applications.

. . . The Discussion Group which examined this entire problem area concluded that industry needs freer access to atomic-energy information than it now has if it is to move expeditiously in the development of peaceful uses . . . [and] . . . recommended that consideration be given to two possible courses of action. First, the Congress might redefine "Restricted Data," so as to limit it to "all data concerning the design, manufacture, or utilization of atomic weapons." This would in effect remove the imposition of the "born classified" concept of data useful to peaceful development. . . An alternate proposal would be to encourage the Commission to speed up down-grading and declassification by whatever means possible and, at the same time, begin serious study of methods to simplify communication of classified matters to the pertinent portions of the industrial community. The Discussion Group concluded that it would not be wise to undertake legislative action until the Congress was satisfied that the necessary balance between development of peaceful uses and protection of national security could not be achieved by administrative action under existing laws.

*From "Background Material for the Report of the Panel on the Impact of the Peaceful Uses of Atomic Energy to the Joint Committee on Atomic Energy, Vol. 2 (1956)."*

### Engineers for Korea

Nearly four hundred young Korean engineers graduated [recently] from Pusan Technical High School, after completing their training in the various workshops and laboratories equipped by the United Nations Korean Reconstruction Agency.

An allocation . . . was made by the Agency for construction materials, shop machinery, equipment and supplies to re-establish technical high schools in Korea.

*UNESCO*

(*More Noted and Quoted on page 54*)
(*Letters to the Editor on page 56*)

DU PONT

Better Things for Better Living ...through Chemistry

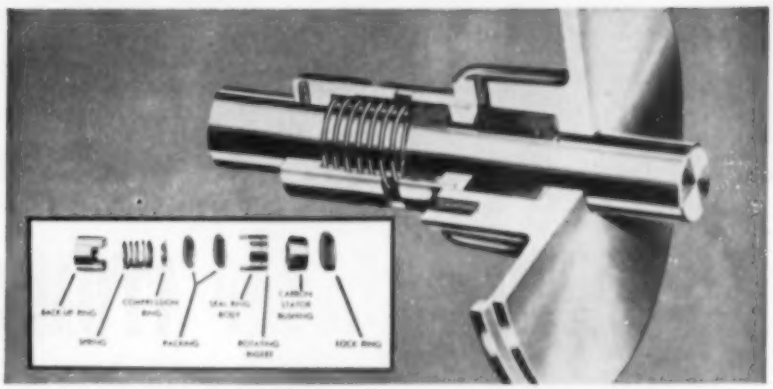
# CHEMICAL ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

No. 9, 1956

# Chemically inert TEFLON® simplifies design in new mechanical seal

# ... offers economical service on pumps handling corrosives



Exploded and cross-sectional view of new mechanical seal, with parts of "Teflon" shown in red. Seal can be rapidly interchanged with packing.

Latest design in mechanical seals features complete and rapid interchangeability with packing. Developed by Chemical Power and Products, Inc., New York City, this new seal can be made to fit any stuffing box, requiring no alterations or special clamps. It offers economy by eliminating product loss and minimizing installation and downtime.

"Teflon" tetrafluoroethylene resin plays the feature role in the sealing of corrosive liquids and slurries. It is used as a shaft packing in the form of a male and female cup, and providing maximum flexibility with minimum spring pressure as a wedge lock in the bottom of the seal to prevent leakage and stop rotation of the stator. The self-aligning wedge lock of "Teflon" slips easily in place, and the time and expense involved in installing a clamp to hold the stator are eliminated.

"Teflon" is selected in sealing applications because of its superior physical and chemical properties. "Teflon" is chemically inert—alkali metals and fluorine, under unusual conditions, are the only ordinary industrial chemicals which will attack it. This unique engineering material will operate at service temperatures ranging from −450° to 500° F. "Teflon" is nonflammable, and has zero water absorption by ASTM test. It has low-temperature toughness and an exceedingly low coefficient of friction.

For handling corrosive chemicals, "Teflon" offers unexcelled service for such items as pump impellers, expansion-joint bellows, filters, tubings, and gaskets and packings. If you have a problem involving extreme heat and corrosion, investigate the use of "Teflon." For property data that will help you analyze your problems in terms of this unique material, clip and mail the coupon below.

## TEFLON® can now be cemented with conventional adhesives

A new process provides a cementable surface on shapes fabricated from "Teflon" tetrafluoroethylene resin. Chemically inert, "Teflon" normally refuses to stick to anything. After treatment, however, "Teflon" may be bonded with conventional adhesives to a wide range of other materials as well as to itself.

## Fittings of ZYTEL® provide leak-proof connections on tubing

Compression-type "Jaco" fittings of molded "Zytel" nylon resin simplify installation and disassembly. In this new design, the ferrule necessary for a leak-proof seal is molded as an integral part of the nut. The resiliency of "Zytel" enabled this fitting to withstand a test of more than 25,000,000 oscillations. "Zytel" forms a non-corrosive connection, impervious to most acids and alkalies, and capable of withstanding pressures to 500 p.s.i. Its service temperature ranges from −70° to 295° F. Fittings are molded by Jaco Manufacturing Company, Cleveland, Ohio.

This versatile Du Pont engineering material is a time and cost saver in many applications where lightness in weight, heat resistance, corrosion resistance and strength in thin sections are essential. Investigate this product further by mailing the coupon below.

## NEED MORE INFORMATION?

Clip the coupon for additional data on the properties and applications of these Du Pont engineering materials.

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department
Room 799 Du Pont Building, Wilmington 98, Delaware
*In Canada: Du Pont Company of Canada Limited, P.O. Box 660, Montreal, Quebec*

Please send me complete property and application data on Du Pont "Teflon" ☐ and "Zytel" ☐.

I am interested in evaluating these materials for

_____

_____

Name_____

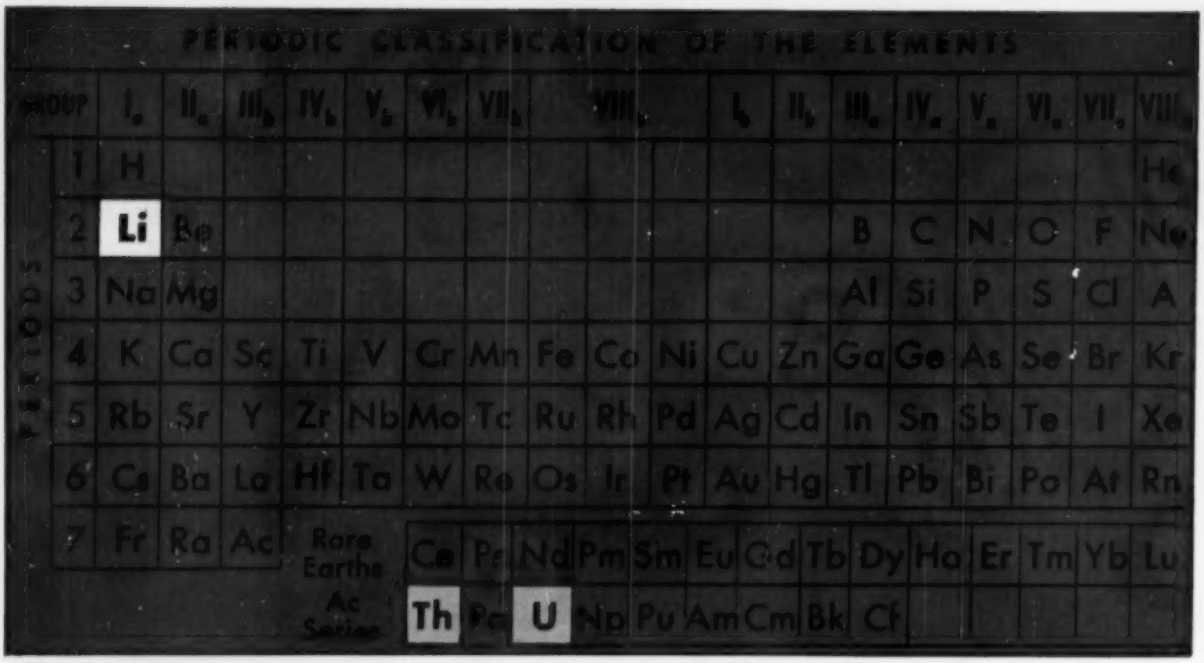
Firm Name_____

Position_____

Type of Business_____

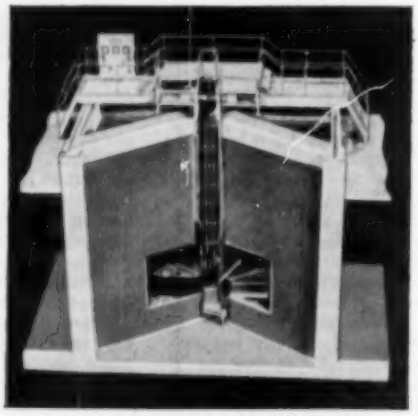
Street Address_____

City_____ State_____


PERIODIC CLASSIFICATION OF THE ELEMENTS
GROUP
I. II. III. IV. V. VI. VII. VIII. I. II. III. IV. V. VI. VII. VIII.
PERIODS
H He
Li Be B C N O F Ne
Na Mg Al Si P S Cl A
K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr
Rb Sr Y Zr Nb Mo Tc Ru Rh Pd Ag Cd In Sn Sb Te I Xe
Cs Ba La Hf Ta W Re Os Ir Pt Au Hg Tl Pb Bi Po At Rn
Fr Ra Ac
Rare Earths
Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu
Ac Series
Th Pa U Np Pu Am Cm Bk Cf

# LITHIUM in the ATOMIC FUTURE

Only in recent years has mention of Lithium in nuclear energy been made. For the past 12 years, however, the technical staff of Lithium Corporation has been accumulating know-how on lithium. The contributions made to the comparatively small store of knowledge on this interesting element are material. Now, with our country on the threshold of peacetime nuclear power, Lithium Corporation stands ready to assist the creators of tomorrow's power. Lithium metal, two metal derivatives, and 15 salts are available for study. You are invited to share the benefits of our use-research into lithium. Write for technical data sheets on this miracle element. It could mean a great deal to you.



Model AMF Atomics Inc. Research Reactor

*trends ahead in industrial applications for Lithium*

LITHIUM CORPORATION OF AMERICA, INC.
2540 RAND TOWER
MINNEAPOLIS 2, MINN.

MINES: Keystone, Custer, Hill City, South Dakota • Bessemer City, North Carolina • Cat Lake, Manitoba • Amos Area, Quebec • BRANCH SALES OFFICES: New York Pittsburgh • Chicago • CHEMICAL PLANTS: St. Louis Park, Minnesota • Bessemer City, North Carolina • RESEARCH LABORATORY: St. Louis Park, Minnesota

# Have you tried MICRO-CEL®

- to absorb liquids
- to provide bulk
- to prevent caking
- to control viscosity
- to extend pigments
- to aid suspension
- to reduce surface sheen

The Powder That Flows Like a Liquid—Micro-Cel, latest development of Johns-Manville Research, will greatly improve the flowability of many products.

**New Johns-Manville mineral filler can help you improve products and cut costs**

WANT to absorb liquids or control viscosity? Try *Micro-Cel*—it absorbs up to 6 times its weight in water, remains a free-flowing powder even after absorbing twice its weight in liquids.

Want to bulk up your compound for better control of package density? Try *Micro-Cel*—a cubic foot weighs as little as 5 pounds.

Want to prevent caking? Try *Micro-Cel*—its high absorption works wonders in controlling deliquescent products.

Want to extend pigments or reduce surface sheen? Try *Micro-Cel*—it combines fine particle size, large surface area and inertness with high absorption suggesting many applications.

Want to assure better suspension of heavy solids? Try *Micro-Cel*—its particle size, as low as .02 micron, provides uniform dispersion and blending.

Micro-Cel is a brand-new line of synthetic calcium silicates produced by combining lime with diatomaceous silica under carefully controlled conditions. Its unique combination of properties has already brought important benefits and savings to many processors. Maybe you will be next. Just mail coupon for further information, samples and technical assistance.

JOHNS-MANVILLE JM PRODUCTS

## Johns-Manville MICRO-CEL

**SYNTHETIC CALCIUM SILICATES**

A PRODUCT OF THE CELITE DIVISION

Johns-Manville, Box 60, New York 16, N. Y.
In Canada: Port Credit, Ontario.
Please send ☐ additional data ☐ samples of Micro-Cel
I am interested in formulating the following products:

_____

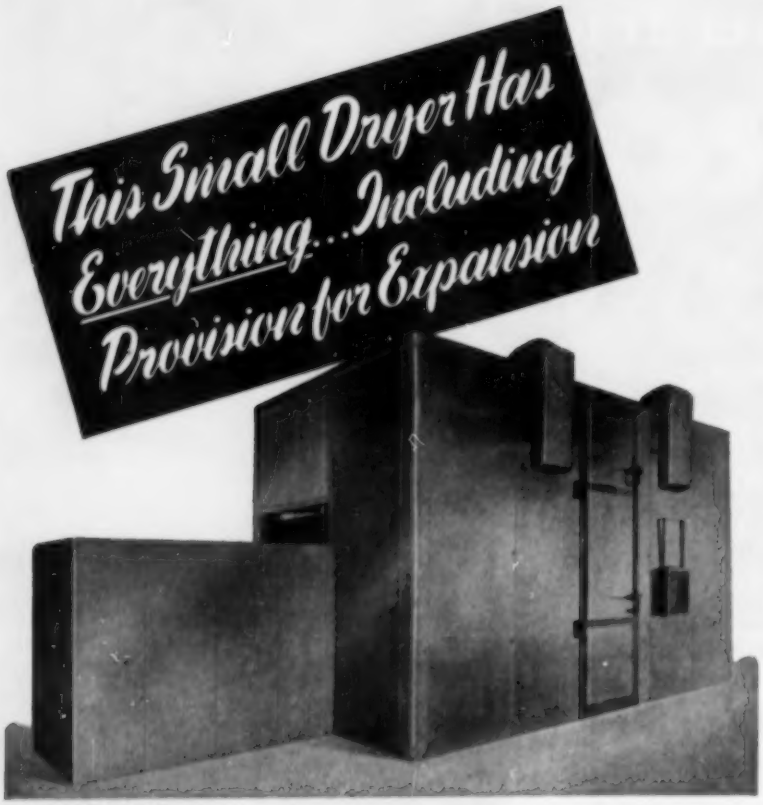
☐ Please have local representative contact me

Name _____ Position _____

Company _____

Address _____

City _____ Zone _____ State _____




# "NATIONAL" APRON CONVEYOR DRYER

**While this comparatively small Apron Conveyor Dryer was installed to immediately provide pilot plant production, it is readily adaptable to expansion to meet future large-scale production requirements. It incorporates all the features available in the largest "National" Dryers of this type, including the following:**

**The most efficient air control devices to assure absolute uniformity of air distribution and condition through the material.**

**Wide flexibility in air delivery by use of adjustable pitch fans.**

**Adjustable sealing of air to eliminate leakage and dust carry-over to chain and other parts of equipment.**

**Newest heavy-duty trussed-type apron hinges.**

**Latest devices for chain alignment control and lubrication.**

*Send for Folder Describing "National" Single and Multiple Apron Conveyor Dryers and Related Equipment*

THE NATIONAL DRYING MACHINERY CO.
LEHIGH AVENUE and HANCOCK STREET
PHILADELPHIA 33, PENNA.

*New England Agent:* JONES & HUNT INC., Gloucester, Mass.
*Cable Address:* "NADRYMA"—W. U. Code


## Noted and quoted

*(Continued from page 50)*

### Plants?

Russia cannot hope to catch up to an alert and determined United States in the production of steel, coal, petroleum, aluminum; well-known synthetic materials such as nylon, or other products of large industry. But she may already be ahead in small products which have never figured importantly in the United States or anywhere else.

Some of these new materials are potentially significant for both war and peace:

Take pentaborane, for instance. This compound of boron and hydrogen is a fuel twice as powerful as the best gasoline or the hottest kerosene now used in airplanes, or the best hydrocarbon-oxygen combination used in rockets. There is virtually no production of it in the United States because there is no way of synthesizing it at a cost which would make it commercially useful. The starting material [sodium borohydride] for the present unsatisfactory process costs $15 a pound. Only one small company turns out small quantities of it by an inefficient batch process . . . [It may be possible to] . . . cut the cost to about $6 a pound. Even so, pentaborane itself when finally processed would probably have a cost of about $25 a pound. This looks sky-high when compared with the few cents a gallon the Government has to pay to tank up a jet bomber with kerosene. But with pentaborane the bomber could fly twice as far, or carry twice the bomb load. If this meant delivering the decisive blow, pentaborane would be the cheapest fuel even if kerosene were free.

. . . [On the other hand] . . . a better way may be found to make pentaborane eliminating sodium borohydride.

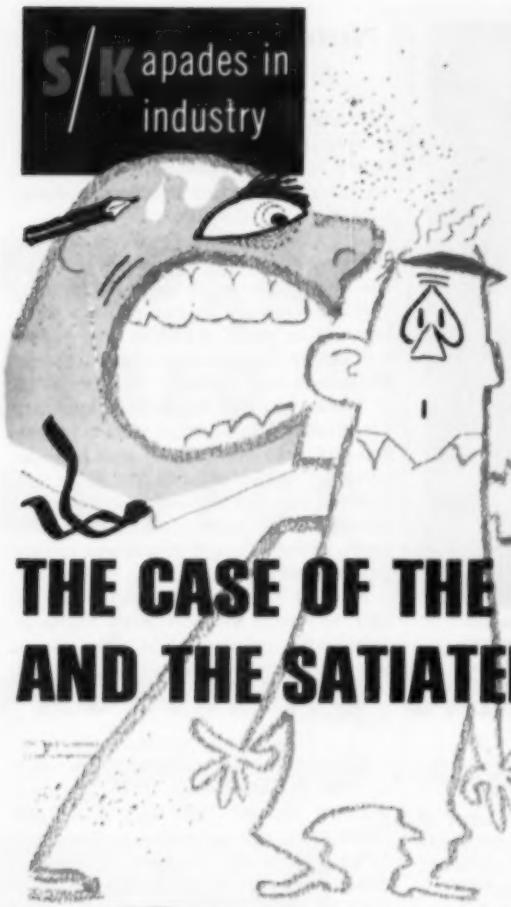
But meanwhile, Russia could be making it in large quantities. Russian industry is neither stimulated nor thwarted by commercial concepts. An investment of $5 million in a borohydride plant would not put a strain on the Russian treasury any more than it would on ours. All that is needed is the determination to make the investment, and behind this would be the purely military need for the chemical.

### Another Soft Spot

Another small industrial field of vital importance is high temperature metallurgy. Columbium, for instance, plays an important role in the formation of

*(Continued on page 56)*

S/K apades in industry



"I'm Fed Up!" screamed Simpkins, the Superintendent. "I've had it, and I'm fed up. That mixer has Got To Go!"

"But boss," soothed Barney, the Bird Dog Assistant, "that mixer can't be shut down. The Front Office has already told us . . ."

"Out!" interrupted the seething Super.

". . . that if we can't spark up production, changes are gonna be made," finished Barney.

"You're Right," said Simpkins coldly. "You're *so* absolutely, *definitely* right. Changes *are* gonna be made—Now!"

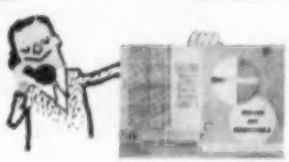
"Can't we talk this over, man-to-man?" mumbled Barney. "Seems to me . . ."

"Sure we can talk it over," said the Super, "*sure* we can. C'mere m'boy. I'll talk, and you listen.

"You've got two weeks. Two weeks to Get That Mixer Out and something an awful lot better in. That's your mission, boy, an out and out case. The mixer or you. Think it over," said the Super, with a man-to-man pat on the back.

# THE CASE OF THE MACHIAVELLIAN MIXER AND THE SATIATED SUPERINTENDENT

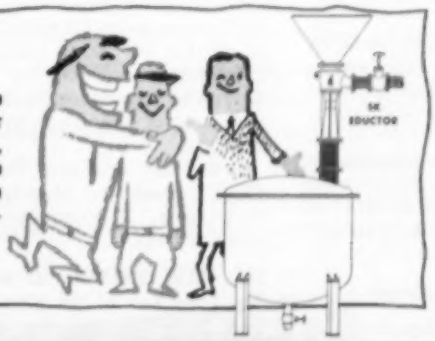
". . . need your help," phoned Barney to his nearest SK Sales Engineer. "I've thought over this problem I've told you about, read SK's Bulletin J-1, and I think a jet of some kind is right for the job."



"YOU'RE RIGHT," replied SK's nearest Sales Engineer. "You're so absolutely, definitely right. An SK Water Jet Eductor will do the job, and I'll be right over to tell you how."

**NO BIRD DOG NOW**

Now, thorough mixing of dry powder and a liquid prior to discharge into a tank is accomplished by the use of an SK Fig. 235 Eductor as shown. Pressure liquid enters the eductor, entrains the powder, mixes the two in the venturi of the eductor and discharges the mixture into a receptacle. The streamline design provides maximum efficiency. No bird dog now, Barney is consulted on every production problem—bowls with Simpkins every Thursday night.




**MORAL:**

*Get acquainted with all types of SK Jet Apparatus. Send for a copy of Condensed Bulletin J-1. Make use of a qualified specialist, your nearest SK Sales Engineer.*

Schutte and Koerting
COMPANY
MANUFACTURING ENGINEERS
2248 STATE ROAD, CORNWELLS HEIGHTS, BUCKS COUNTY, PA.

JET APPARATUS: Ask for Condensed Bulletin J-1.
ROTAMETERS & FLOW INDICATORS: Ask for Condensed Bulletin 10-RA.
VALVES: Ask for Condensed Bulletin V-1.
HEAT TRANSFER APPARATUS: Ask for Condensed Bulletin HT-1.
GEAR PUMPS: Ask for Bulletin 17-A.

University of Michigan laboratory technicians handle a low-level radioactive sample in the "hot storage" area. The standard Corning shield is 36 inches thick. Corning will also build any custom shield you want.

## The radiation window that gives you a view as clear as this costs the least

If you were actually standing outside the University of Michigan's radiation cave number 2—instead of looking at a screened reproduction of a photograph—you'd be able to see clearly any small detail you wanted to.

Anything you could read with your naked eye you could just as easily read through this yard-thick, almost water-white Corning Radiation Shielding Window.

It's made of 3.27 density Corning Code 8362 lead glass that inch-for-inch matches dense concrete for shielding. Nonbrowning Code 8362 doesn't lose transparency with time.

You need no fluid shielding medium with the Corning window. There's nothing to replace or recondition. It comes as a "package"—ready for insertion in your cell wall.

Nonbrowning, nondiminishing shielding, resistance to abrasion plus the most shielding per dollar of any window, all make Corning Code 8362 the most economical shield you can buy.

**BRIEF SPECIFICATIONS**

Code 8362 has a refractive index of 1.594 and an internal transmittance of 93% in 5" thickness with sodium lighting. It's chemically stable, indifferent to moisture, and optically clear.

It's cerium stabilized, resists browning and recovers rapidly from tinting. You can order single-piece thicknesses to 12" and sizes up to 100" x 70". We'll make the window you need to your specifications.

For detailed information, write to us.

**FOR LEAD AND STEEL WALLS**

Corning Code 8363, a 6.2 density glass, meets the requirements of lead and steel walls, or backs up Corning Code 8362 in 300 lbs. per cu. ft. concrete walls. Combinations of Corning Shielding Glasses have been installed in windows with a total glass path of over 200 density inches.

Write for Technical Bulletin No. PE-50, "Radiation Shielding Glasses by Corning." It covers properties and characteristics.

**SEE THESE WINDOWS at our exhibit. The Trade Fair of the Atomic Industry Sept. 24-28, 1956, Navy Pier, Chicago, Ill.**

*Technical Products Division*

**CORNING GLASS WORKS**

**24-9 CRYSTAL STREET, CORNING, N. Y.**

*Corning means research in Glass*

## Noted and quoted

*(Continued from page 54)*

a certain high temperature alloy. There is only one company in the United States refining columbite ores . . . a specialist in tantalum products, making columbium on the side.

. . . [With regard to tantalum] the Russians could easily be ahead of us. An investment of $1 million can add very substantially to our nation's total capacity to make tantalum and refine columbium—an investment of a mere $5 million will multiply it many fold. If Russia has put $10 million into this branch of industry, it has a much bigger capacity than we have or can hope to have for several years. The fact that Russian jet engines now in use are admittedly much more powerful than ours could reflect a larger investment in this field of metallurgy.

Another financially neglected field of new endeavor in the United States is rare earth refining. The rare earths are not rare in a geological sense, but they have been and still are very expensive.

. . . [One firm] has been the principal processor of rare earths for most of this century. Until 1955 its plant account showed less than $1,000,000 invested in manufacturing facilities. A large government contract for thorium boosted this to about $3,000,000. But this shouldn't be hard for the Russians to match.

. . . America must become aware of its "Achilles' heel," which is the balance sheets of its small specialty material and service companies. These balance sheets are dangerous to our safety because they indicate how easy it is for Russia to get ahead of us in the vital fields of new scientific discovery, while we rely too much on our great power in old materials.

*Walter K. Gutman*
*in Investor*

## Letters to the editor

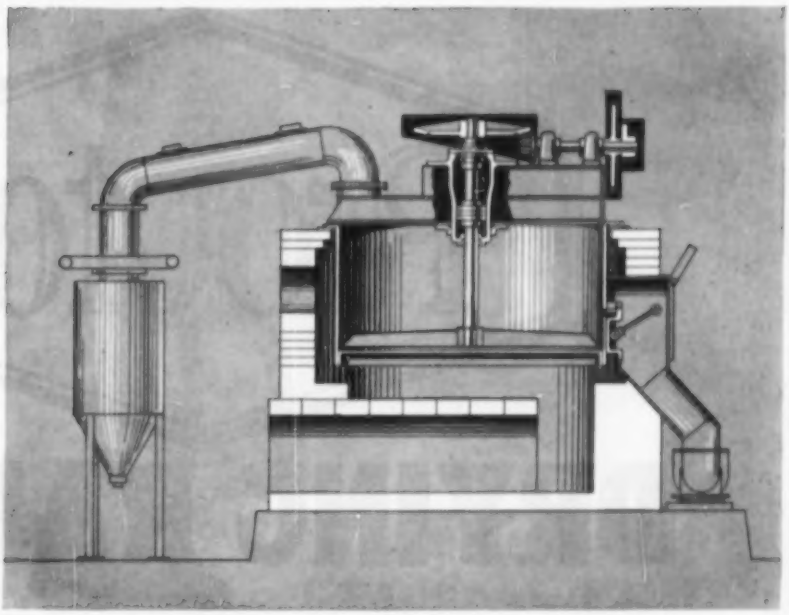
### Refresher for Engineers

Since reading news of the courses offered by the Charleston, W. Va., section for chemical engineers (C.E.P., page 106, June, 1956) it occurs to me that you may be interested in learning of courses which this section [Washington-Oregon] has run this past year.

The two identical courses were offered both in Seattle and in Shelton, Washington. The 24 class meetings

*(Continued on page 59)*

# UNDER FIRED DRYERS *for* PROCESSING URANIUM PRECIPITATES *and a wide variety of other materials*



Special Steam Jacketed Batch Dryer Showing Dust-tight Discharge Housing and Condenser.

Steam Jacketed Pot-type Dryer Fitted with Rotary Sweep.

Oil or gas fired, these batch type dryers are suited for processing at 700° F, or other temperatures beyond the range of steam,— also when steam is not available. Mild steel, stainless or alloy construction. The material is loaded through the top. A sweep agitates the charge to assure thorough, uniform processing, and discharges the material through the side door — and a dust-tight discharge housing if desired — to a screw or other type conveyor. Exhaust gases are drawn off through the top and can be passed through a condenser to reclaim the fines.

Let our heat engineering specialists, with their wide and successful experience in continuous and batch processing, work with you on your next project. We can handle all phases of the problem including complete materials handling, storage and dust collection. This assures fixed unit responsibility; the smooth synchronized operation of all parts of the installation; and utmost economy and satisfaction.

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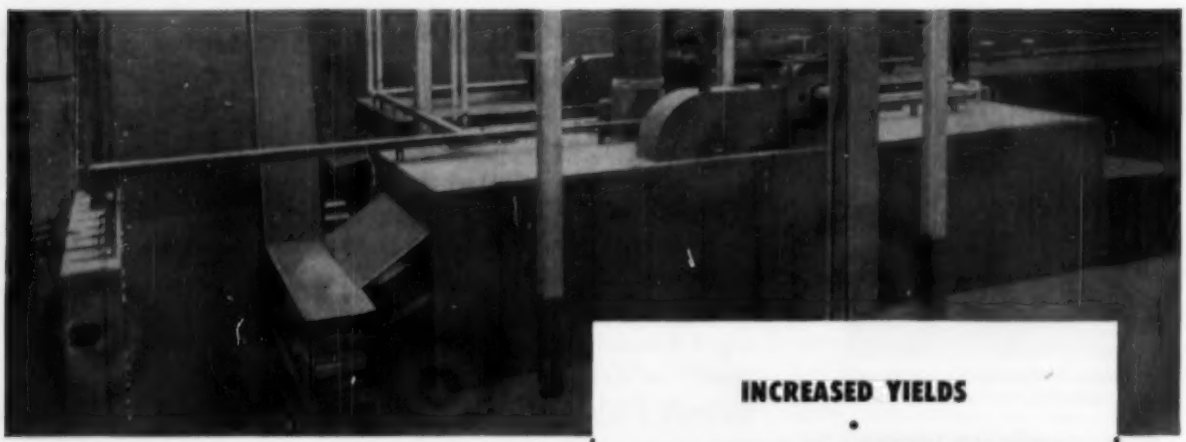
**DRYERS • COOLERS • CALCINERS • KILNS — *Complete Facilities Including Materials Handling***

# Proctor

# DRYING RANGES

*for*

## *highest product uniformity!*



**PRODUCT UNIFORMITY** is of utmost importance to every food processor, at all stages of processing. The Proctor continuous conveyor dryer installation shown above is located in a plant of one of the world's largest food manufacturers—typical of many in use in the food industry today. In this plant Proctor Dryers assure uniformity of color, taste, and high customer appeal—yields are greatly increased!

**WITH UNIFORMITY COMES PROFIT.** Efficient drying per pound of product can often mean more direct profit than an increased sales volume. Proctor equipment provides the control, flexibility and construction features *essential* to profitable drying performance. Write or phone today for complete information.

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**FLEXIBILITY**

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**PROFITABLE OPERATION**

**OTHER PROCTOR DRYING EQUIPMENT FOR THE FOOD AND PROCESS INDUSTRIES**

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PRE-FORMING FEEDS • SPRAY DRYERS

**PROCTOR & SCHWARTZ, INC.**

Philadelphia 20, Pa.

Proctor

MANUFACTURERS OF INDUSTRIAL DRYING EQUIPMENT AND TEXTILE MACHINERY

## Letters to the editor

(Continued from page 56)

lasted for two hours each and extended from [October 3-April 6] and were held weekly except for the Christmas holiday season. There were 30 registrants in Seattle and 45 in Shelton. The tuition charge was $30 for the entire 48-hour course and included the extensive notes distributed by the lecturers. In most cases, the tuition charge was defrayed by the employer of the registrant.

Enclosed are the complete syllabi [in abbreviated form below] for your information. A great deal of subject matter was encompassed in this relatively brief period, essentially the entire subject matter of the undergraduate chemical engineering curriculum. The course was intended as a refresher; the students were graduate scientists, most of them chemical engineers.

**SYLLABUS FOR CHEMICAL ENGINEERING REFRESHER COURSE**

(Washington-Oregon Section, A.I.Ch.E.)

STOICHIOMETRY

*Introduction; Graphical and Other Integrations; Stoichiometry; Material Balances on Weight and Atomic Bases; The "Tie-Substance."*

*Gas Stoichiometry and Calculations; Vapor Pressure.*

*Recycle; Accumulation and Depletion; Introduction to Energy and Heat Capacity.*

*Heat Balances; Typical Combustion Balances.*

*First Law; Non-Flow and Flow Cases; E, H, w and q.*

THERMODYNAMICS

*ΔE, ΔH, w and q Calculations for Various p. g. Processes.*

*Gas Behavior; Compressibility; Modification of Above Calculations to Account for Deviations.*

*Second Law; Entropy; Carnot and Other Cycles; Work Cycles; Refrigeration; Heat Pumps.*

*Graphical and Tabular Data; Steam and Engines; Turbines; ΔB and Worth of Steam; Accumulators.*

*Free Energy, Fugacity, Exact Isothermal Work (Flow); Chemical Equilibrium.*

*Phase Equilibria.*

UNIT OPERATIONS

*Fluid Flow.*

*Heat Transfer and Dim. Anal. Conduction and Convection.*

*Radiation; Combinations; True Gas Temps.; Unsteady State and Gurney-Lurie Charts.*

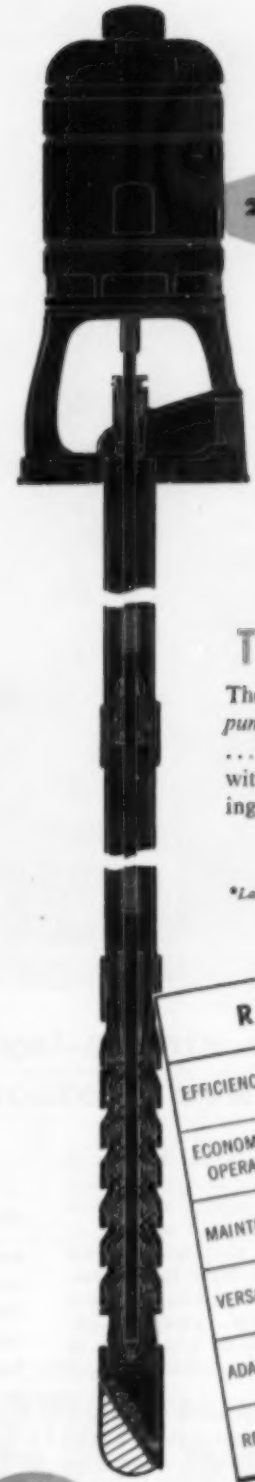
*Evaporation; Mult. Effect Calculations; Enth-Concentration Charts.*

*Distillation*

*Absorption.*

*S-L and L-L Extraction.*

(Continued on page 62)

CAPACITIES TO 7500 GPH

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FOR WELLS AS SMALL AS 4"

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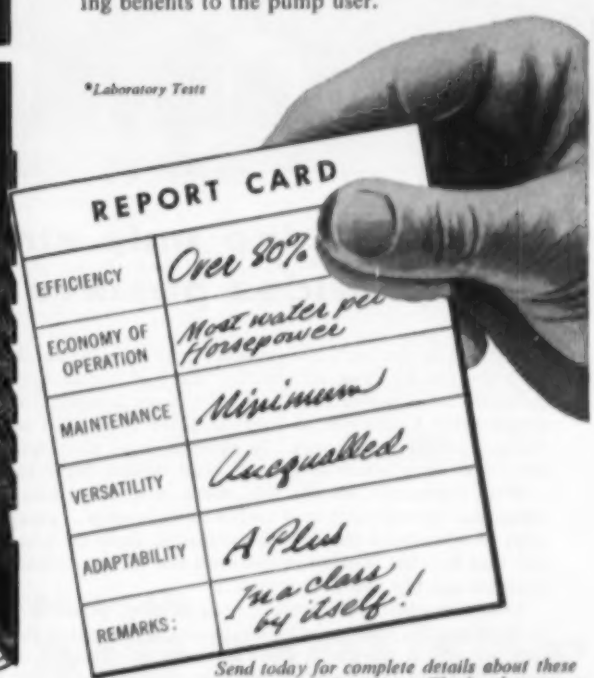
The Verti-Line Package-Pump represents *another pump improvement* by Layne & Bowler engineers ... Again, Layne & Bowler is *first* in the field with a new design that means many money-saving benefits to the pump user.

*Laboratory Tests




*Send today for complete details about these amazing pumping units ... They're the answer when you want a small pump for big jobs!!!*

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*Verti-Line Pumps are the exclusive products of*

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Unibestos is the only single-layer pipe insulation that's built with the strong, long interlacing fibers of Amosite, the quality asbestos from South Africa. This unique construction permits single-layer Unibestos to form positive heat seals at hard-to-insulate joints and fittings...to provide more protection against heat loss than other single- or even double-layer insulations.

With Unibestos on the job, there is less shrinkage...more resistance to moisture, acid and chemical fumes...greater toughness to withstand shock and vibration. Easy to miter, easy to cut, this durable insulation goes on the most complex pipeline systems quickly and economically.

Fast, low-cost application...long-lasting, positive protection—these are the reasons why Unibestos is becoming the specified insulation for more and more of today's industrial operations. Unibestos® is available in sectional form through 44" O.D.

**Joe Bestos says:**

**Remember when insulating those tough fittings, single-layer Unibestos locks in more heat than other single- or double-layer insulations!**

For complete information write...

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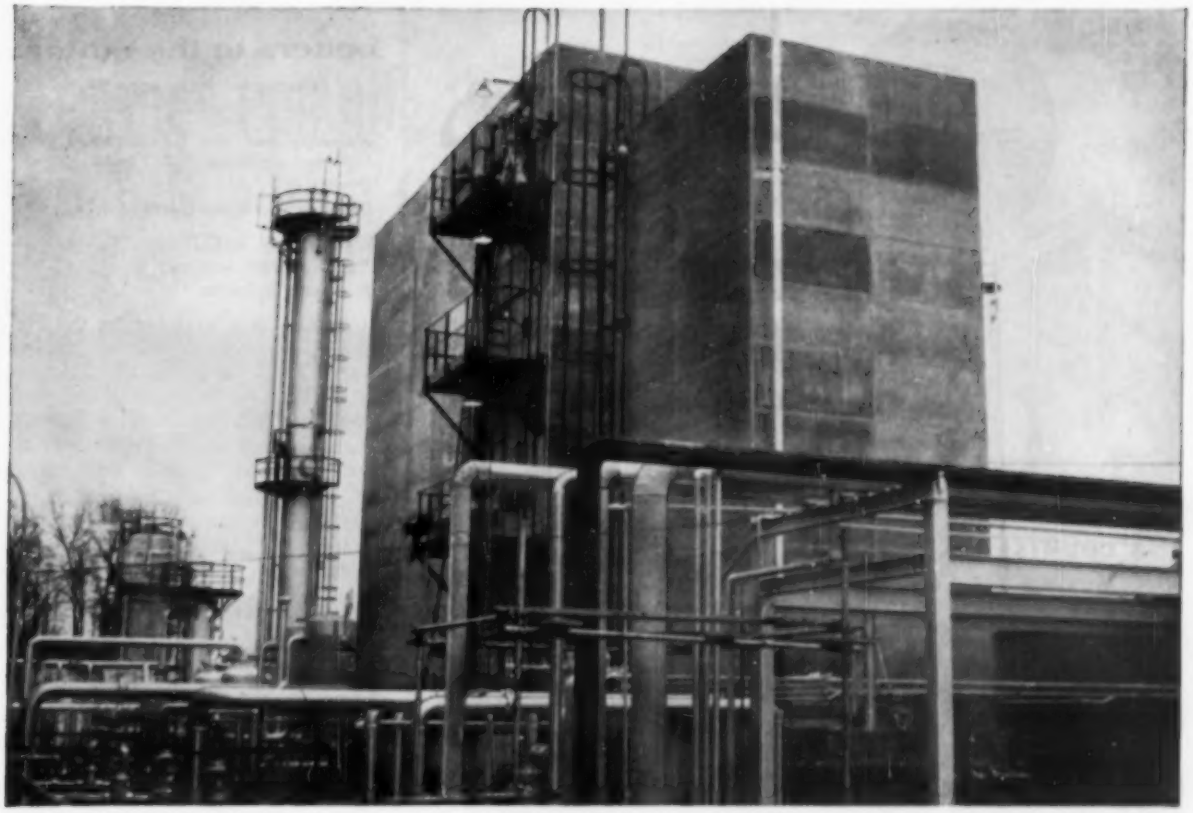

Tonnage Oxygen Unit and Ammonia Synthesis Gas Purification Unit, designed and built by Air Liquide for Mississippi River Chemical Company, in Selma, Missouri, and erected by Fluor Corp., Los Angeles, Cal.

# DOES LOW-TEMPERATURE GAS SEPARATION FIGURE IN YOUR PROCESSING PLANS?

Why not consider the economic and other advantages of low-temperature gas separation methods in your processing program? Engineering specialists in this field are readily available to ensure sound modern design, top-quality fabrication of equipment, efficient erection and operation.

*That* special combination of knowledge and skills is at your service when you engage Air Liquide. Low-temperature gas separation has been our business for over half a century.

During the past fifty years AIR LIQUIDE has designed and built over 1000 hydrocarbon and air-separation plants for industries throughout the world, more than 150 of them in America. They are used to recover a variety of high-purity products, including Hydrogen, Carbon Monoxide, Methane, Ethylene, Oxygen, Nitrogen, and rare atmospheric gases.

Address your inquiries to: American Air Liquide, 529 Chrysler Building, New York 17, N. Y.

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ENGINEERING & CONSTRUCTION DIVISION

OLDEST IN EXPERIENCE—NEWEST IN DESIGN

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# 1-Piece

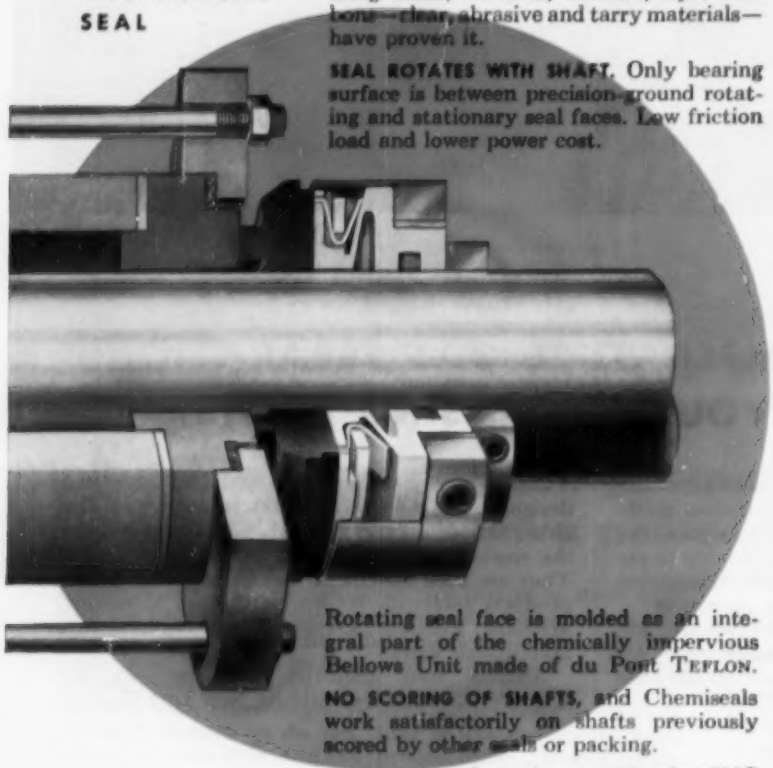
## CHEMICALLY IMPERVIOUS PRESSURE-BALANCED TEFLON BELLOWS DESIGN

*Chemiseal Mechanical Seals last longer and give unsurpassed performance under a wide variety of chemical service conditions.*

● CHEMISEAL MECHANICAL SEAL

Four years of actual field service, handling acids, alcohols, alkalies, hydrocarbons—clear, abrasive and tarry materials—have proven it.

**SEAL ROTATES WITH SHAFT.** Only bearing surface is between precision-ground rotating and stationary seal faces. Low friction load and lower power cost.



Rotating seal face is molded as an integral part of the chemically impervious Bellows Unit made of du Pont TEFLON.

**NO SCORING OF SHAFTS,** and Chemiseals work satisfactorily on shafts previously scored by other seals or packing.

**PRESSURES** at the seal up to 100 psi at 75°C or 75 psi at 100°C.

**SIZES** from ⅞" to 2½". Other sizes on special order.

**MAXIMUM LENGTH,** all seals 2½".

Ask your U.S. Gasket-Belmont Packing Distributor or write for Bulletin No. MS-1155.

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**UNITED STATES GASKET CO.**
Camden 1, New Jersey

**U.S. GASKET • BELMONT PACKING**


## Letters to the editor

(*Continued from page 59*)

*Humidity and Air Conditioning; Wet Bulb and Adiabatic Sat. Temps.*
*Drying.*
*Granular Particles Operations.*

GENERAL SUBJECTS
*Kinetics (two sessions).*
*Economic Balances.*

It was quite a work-out for the five lecturers involved, as well as for the students. A post-course questionnaire indicated that the objectives of the series were pretty well gained. There appears further demand for a repetition of the course next year in another location.

*George C. Szega*
*Seattle and Shelton*
*Washington*

### Trends in Foreign Chemicals

We were interested to read the article headed "CEP Trends/Foreign Chemicals" on page 49 of the issue for May 1956.

We are enclosing a copy of a brochure which describes our activities in this field.

As you are no doubt aware, this Company is also a very large producer of petroleum chemicals and you may therefore find the enclosed brochure of interest.

*C. E. Evans*
*Grangemouth, Stirlingshire, England*

**We acknowledge with thanks Mr. Evans' kind letter which amplifies our recent summary of important petrochemical developments abroad (CEP, May, 1956). Mr. Evans is general manager of British Hydrocarbon Chemicals Ltd., a company formed in 1947 by the British Petroleum Co. Ltd. and the Distillers Co. Ltd. which was making ethyl and isopropyl alcohols from petroleum by 1951. In 1950 the company joined with Monsanto to form Forth Chemicals Ltd., producing monomeric styrene early in 1953. By the end of 1955 a third company, jointly owned by BHC and Oronite Chemical Co. of California, was producing dodecyl benzene.**

### Back to McGuffey

Referring to the Argonne National Laboratory advertisement on p. 112 of the July issue of *Chemical Engineering Progress*, is "flourine" related to "phosphorous"?

*E. M. Elkin*
*Montreal, Quebec*

**Reader Elkin is corect. Our appologies.—Editor.**

# Girdler building $5,000,000 addition for B. F. Goodrich Chemical Company

A GREATLY INCREASED flow of Geon polyvinyl chloride resins and other plastic compounds will soon be coming from B. F. Goodrich Chemical Company's plant at Avon Lake, Ohio. Girdler—who engineered and constructed existing facilities—will act as general contractor for the expanded processing plant.

The plastic resins which are produced here are the raw materials for an ever-increasing number of products ranging from plastic pipe to Army ponchos, from truck tarpaulins to circus tents.

Naturally, Girdler feels proud of being entrusted with responsibility for this expansion project. It's a good indication that our experience and ability pay off in performance. Keep this in mind when *you* plan process plant expansion or modernization and take advantage of our *complete* service and vast experience, too. Call or write for complete information.

the **GIRDLER** Company

A DIVISION OF NATIONAL CYLINDER GAS COMPANY

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**GAS PROCESSES DIVISION** . . . Design, Engineering, Construction of Hydrocarbon Processing Plants, Gas Producing Plants, Chemical Plants. High-grade specialty Catalysts.
Offices: New York, San Francisco

**VOTATOR DIVISION** . . . Continuous Processing Apparatus for liquid and viscous materials. Design, Engineering, Construction of Edible Oil Plants.
Offices: New York, Atlanta, Chicago, San Francisco

**THERMEX DIVISION**... Dielectric Heating Apparatus for materials drying, baking, curing.

# 7 . . . Compelling Reasons are attracting Chemical Plants to the Land of Plenty . . .

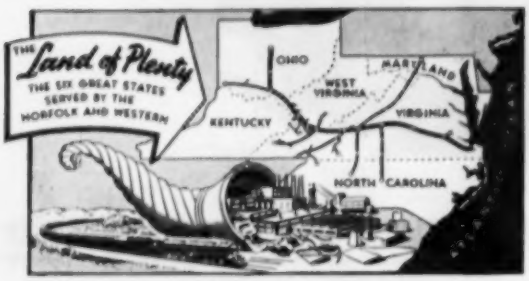
The rich territory served by the Norfolk and Western has seven outstanding competitive advantages for the chemical industry. That's why more and more chemical plants are being located here.

In addition to the seven advantages listed here, the Land of Plenty has many other favorable characteristics — access to world markets through the strategic Port of Norfolk on famed Hampton Roads, moderate year-round climate, friendly folks who make newcomers feel welcome, and excellent recreational facilities.

If you would like to receive more detailed information on the Land of Plenty, please call on our plant location specialists. They will furnish you with facts — not sales talk — in confidence and without obligation.

*Write, Wire or Call:*

**L. E. Ward, Jr., Manager**
**Industrial and Agricultural Dept.**
**Drawer CP-727 (Phone 4-1451, Ext. 474)**
**Norfolk and Western Railway**
**Roanoke, Virginia**

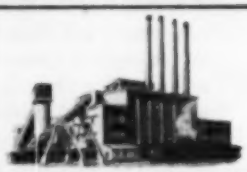



**1.** Next door to the world's finest all-purpose Bituminous Coal

**2.** Ready access to vast sources of limestone of the highest purity

**3.** Nearness to established markets, plus booming new ones

**4.** Ample electric power and industrial water



**5.** Plenty of productive, home-rooted workers

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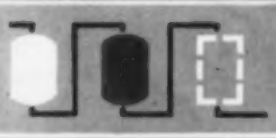
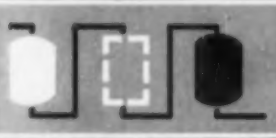
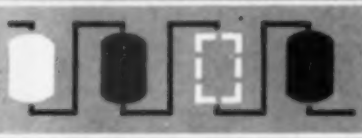
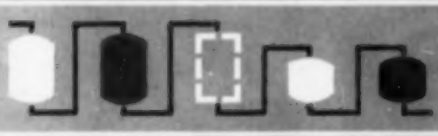
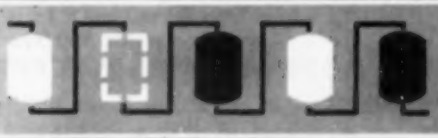
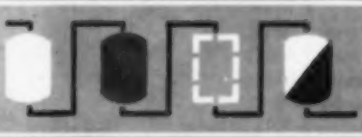
**Norfolk and Western Railway**

# 9 ways to demineralize water

## (BY ION EXCHANGE)

KEY: **Hydrogen Cation Unit** — Removes metallic cations such as calcium, magnesium, sodium. Regenerated with sodium for simple water softening. **Weakly Basic Anion Unit** — Removes strongly ionized acids such as sulfuric, hydrochloric, nitric. **Strongly Basic Anion Unit** — Removes strongly ionized acids, also weakly ionized acids such as silicic and carbonic. **Mixed Bed Unit** — Contains both Hydrogen Cation and Strongly Basic Anion Exchangers, intimately mixed. **Degasifier** — Optional. Reduces load on Strongly Basic Anion Exchanger by removing free $CO_2$ brought in by raw water or developed in cation unit.

| | | |
|---|---|---|
| A |  Effluent Conductivity—10 to 30 micrombos (no silica reduction) | Uses low-cost anion exchanger and anion regenerant (soda ash). Typical use—removing soluble salts from water for ceramic mixes and slips or from rinse waters used before painting, mirror silvering, etc. |
| B |  Effluent Conductivity—same as A. Silica content—0.02 to 0.15 ppm. | Used for treating feedwater for boilers in general range of 600 to 1400 psi. Also (without degasifier) for removing impurities from plating baths and recovering chromate from plating rinses. |
| C |  Same effluent as B. | For raw water with high sulfate and chloride content. Low-cost Weakly Basic Anion Exchanger removes major portion of electrolyte load. Countercurrent regeneration of anion units reduces operating costs. |
| D |  Effluent Conductivity—2 to 5 micrombos. Silica same as B. | For same type of raw water as C. Countercurrent regeneration of both cation and anion units cuts operation costs. |
| E | Effluent Conductivity—1 to 3 micrombos. Silica same as B. | For waters where alkalinity is a major part of the anion content. Polishing units require infrequent regeneration. Produces, at low cost, low-solids feedwater suitable for high pressure boilers (over 1400 psi). |
| F |  Same effluent as E. | High flexibility of operation. Can operate in parallel for peak flows. Can maintain service flow during regeneration of either pair of units. |
| G | Effluent Conductivity—less than 1 micrombo. Silica same as B. | Produces effluent of extremely high quality. Suitable for "super critical" pressure boilers and atomic reactors. (Initial and operating costs are usually higher than for separate anion and cation units.) |
| H |  Same effluent as G. | For raw water with high sulfate and chloride content. Two-step demineralizer reduces load on Mixed Bed unit, cuts operating cost. (Strongly Basic Anion Exchanger is used in place of Weakly Basic where raw water has high silica and alkalinity.) |
| I | Same effluent as B. | Recommended where alkalinity of raw water is high. Cation unit and Degasifier reduce load on Mixed Bed unit, cut operating costs. |

All of the above systems, with equipment and resins made by Permutit, are in commercial use. Other combinations are possible—also use of special ion exchangers such as PERMUTIT SK for separating uranium oxide from other metallic oxides in ore.

Most of these systems (C and higher) are used almost exclusively for demineralizing feedwater for high-pressure boilers . . . but the list of possible applications in other fields is growing.

If you have a problem ion exchange might solve, we'll be glad to study it with you and bring you the benefits of this experience. Address: The Permutit Company, Dept. CEP-9, 330 West 42nd St., New York 36, N. Y.

**PERMUTIT**®

rhymes with "compute it"

**ION EXCHANGE** for Water Conditioning

Chemical Processing • Industrial Waste Treatment

# Finds "Our Paul O. Abbé Mixers GIVE WELL BALANCED PERFORMANCE"

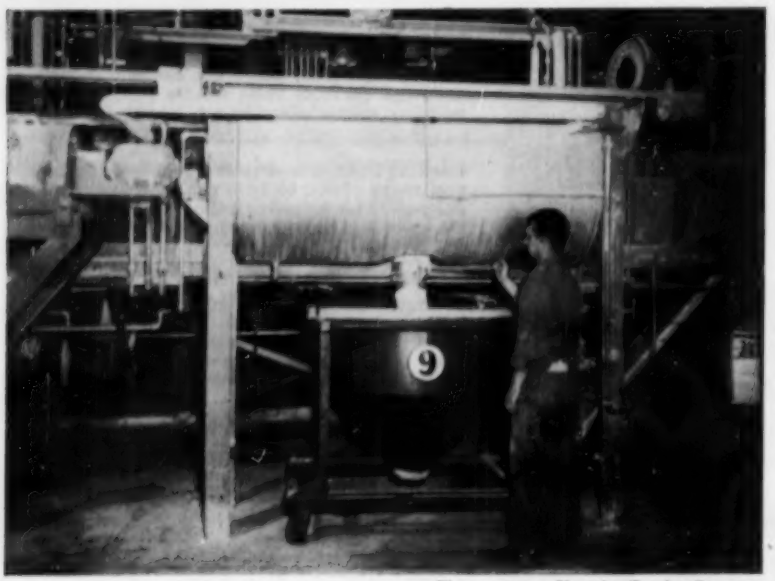


*Photo courtesy Hercules Powder Company*

**A well-known manufacturer had to mix cellulose acetate with various colorants.**

***They wanted:***

1. **To get homogeneous mix.**
2. **To eliminate any possibility of contamination or discoloration from one batch to the next.**
3. **To obtain maximum size of batch.**
4. **To be able to mix a wide range of formulations without lumping.**

**Their Paul O. Abbé Mixers have met every need.**

**"What we were looking for was a versatile mixer—one that met every one of our requirements to a high degree," they state.**

**"Our Paul O. Abbé Mixers we find give well-balanced service. They are versatile. They rank high in meeting our requirements."**

**You, too, may find Paul O. Abbé Mixers help you solve your mixing problems.**

***Write today for Catalog "V-1," describing our line of dry and paste mixers.***

**PAUL O. ABBE**

**271 Center Avenue** **Little Falls, New Jersey**


## About our authors

**G. M. Reinhart** of Fernald tells us that previous work with National Lead's "Bentone" gelling agents had hardly prepared him to cope with the sea of mud which surrounded his first Fernald assignment: the pilot plant. The most difficult part of the job was getting to and from it. Steam supply was from a locomotive, and in extremely cold weather the pilot plant heat exchangers were shut down until the site buildings had gotten up to "occupancy temperature."

**"Chuck" Dryden** of Ohio State has been on leave as a consultant, which has enabled him to view all of the major AEC installations in connection with GE's interests. His comment: "To an average engineer, the type of engineering work that goes on in this field is a real 'eye opener'."

**I. H. Welinsky** lists as one of his unusual jobs, in connection with the nuclear program, a tour as technical observer on board the nuclear powered submarine Nautilus during its early sea trials in 1955. Now with Westinghouse's Atomic Power Division (Bettis Plant), he is working in the development and operation of pressurized water nuclear power plants.

**F. P. Vance** joined Phillips Petroleum in 1946 as a chemical process engineer, got into operations research work. He is now chief of the Operations Evaluation Group at the Idaho Falls nuclear installation. **F. H. Tingey,** author with Mr. Vance of the paper in this issue, gained his first atomic energy experience with General Electric at Hanford, joining Phillips at Idaho Falls in 1954. He is now manager of the Idaho Falls Operations Evaluation Group.

**D. S. Arnold,** with associates A. Whitman and F. J. Podlipec, supervised the technical aspects of the start-up of nitric acid recovery facilities at the Fernald uranium refinery. The three have also been responsible for technical service functions in this installation and for pilot scale operations.

*(Continued on page 70)*

Chinese-food fancier's delight: La Choy chop suey and golden-brown noodles!

# *Here's where Dowtherm really pays off for La Choy*

**UNIFORM TEMPERATURE WITH DOW HEATING MEDIUM ENDS DIRECT-FIRE PROBLEMS**

Uniformly cooked La Choy noodles coming from the fryer.

La Choy Food Products, Archbold, Ohio, has always thought quality control most important. With their previous direct-fire heating system it was necessary for them to give close inspection to the noodles to maintain their high quality. In keeping with La Choy's policy of quality improvement they installed equipment heated with Dowtherm®.

Now, a gas-fired vaporizer heats the Dowtherm, and the Dowtherm vapors maintain the cooking oil at precisely the right temperature. No pump is required in the condensate return line, since the heating equipment is located above the vaporizer and flow is by gravity.

The uniform temperatures provided by this modern heat-transfer medium assure consistent quality . . . batch after batch after batch. Not one can in a thousand is rejected. And equally important—thanks to Dowtherm—every La Choy noodle reaches customers perfect in color and flavor!

Operating on a closed vapor system, Dowtherm minimizes fire hazards; provides temperatures to 750° F. at pressures below 150 p.s.i. Local overheating is eliminated.

If *your* product requires high process heat, further data on Dowtherm will prove valuable. Perhaps we can arrange for you to inspect in operation a system which employs Dowtherm. Write THE DOW CHEMICAL COMPANY, Midland, Michigan, Dept. DO826B.

*you can depend on* DOW CHEMICALS

DOW

# Convert Liquid Chlorine to Dry Vapor Fast and Economically!

Where relatively large quantities of chlorine in dry gaseous form are required, this Whitlock Vaporizer System provides high capacity output at low cost. The System is standardized in design and complete in itself. To operate, it is only necessary to connect steam, condensate, chlorine, and vent lines. The efficient design and rugged construction suggested by the standards of The Chlorine Institute, Inc., make this System extremely compact and economical. Controls are simple and reliable — assure safe, easy operation.

**THE WHITLOCK MANUFACTURING CO.**
**West Hartford 10, Connecticut**
In Canada: Darling Bros., Ltd., Montreal

# Whitlock

**Designers and builders of bends, coils, condensers, coolers, heat exchangers, heaters, piping, pressure vessels, receivers, reboilers**

**The Vaporizer** is available in five standard sizes with ratings from 500 to 8000 pounds per hour. Write for descriptive Bulletin 1328 and prices.

Advertisement

# Corrosioneering News

Quick facts about the services and equipment available to help you reduce corrosion and processing costs.

*Published by The Pfaudler Co., Rochester, N.Y., U.S.A.*

## A new glassed steel autoclave

### Handles reactions up to 750 psi

Your experiments with reactions involving high pressure and corrosive liquids have led to the development of a new, specially designed autoclave – now available to you at Pfaudler.

The new autoclave permits you to conduct reactions where internal pressures go as high as 750 psi with complete safety. Glassed steel construction prevents any undesired catalysis in the product from occurring. And you can study the reaction of highly corrosive liquids with the knowledge that no harm will come to the autoclave.

Since it is constructed of glassed carbon steel, the new autoclave gives you the corrosion resistance of glass and the structural strength necessary to withstand high pressures. Capacities are 1, 2, and 3 gallons.

You get a wide selection of agitation from the variable-speed drive—the two-blade impeller agitator is glassed steel, too. Provision has been made for a thermometer well and the nonmetallic rotary seal is equipped with pneumatic lubrication.

To find out more about these new autoclaves, write to us and ask for Bulletin 939.

## ANNOUNCING PFAUDLER'S NEW FILM-TYPE EVAPORATOR

### Now you can uncover areas of greater profit with this simple-to-operate still

Pfaudler has added an important new member to its growing family of products – a wiped-film evaporator for vacuum distillation.

It is a new improved evaporator which offers low-cost development opportunities to many industries e.g. chemical process, food, pharmaceutical, plastics, petroleum.

A *floating carbon blade* acted upon by centrifugal force cleanly wipes the peripheral evaporating surface to promote a very thin film and turbulence—creating higher heat transfer rates and faster evaporation.

Here are the benefits you get from using the Pfaudler evaporator:

1. IMPROVED HEAT TRANSFER—Very high heat transfer rates even for highly viscous products due to turbulence promoting carbon blades.
2. SHORT CONTACT TIME—No deterioration for heat sensitive materials.
3. CONSTANT UNIFORM FILM – The walls are wiped by actual contact of the carbon blades. This is the only positive means of inducing controlled turbulence and uniform film thickness. Fouling and solids-build-up are eliminated.
4. LOW-COST PROCESS—Because of the short contact time, high heat transfer rate and low power consumption of this evaporator, your operation can be more efficient and less costly.
5. SPACE SAVING – An internal condenser is built into the still eliminating an external condenser and interconnecting piping.
6. LOW MAINTENANCE RATE – Slow speed wiping minimizes wear. Closely machined tolerances between wall and wiper blades are not necessary because contact between the wiper and the wall is due to centrifugal force. Thermal expansion does not affect the operating efficiency of the wiper blades. No foot bearing is required.
7. LOW PRESSURE DROP – Pressure drops between evaporator and condenser as low as 1/10 mm Hg at one mm Hg operating pressure.

#### Two models available

Two Inch Laboratory Evaporator, complete with rotor motor, heating mantle, two 500-m.l. receiver flasks, batch-type feed flask, degasser, Teflon wipers, 24/40 standard taper joints.

For 115 volt, 1 phase,
50-60 cycle power ..... $391.00
For 250 volt, 1 phase,
50 cycle power ..... $397.00

Twelve Inch Pilot Plant Evaporator, stainless steel, complete with ¼ HP variable-speed rotor motor, 4 sq. ft. heat transfer surface in jacket, 6 sq. ft. heat transfer surface in internal condenser, vacuums to 0.1 mm or lower, temperatures up to 700 F., very high capacities. For 220 volt, 1 phase, 60 cycle power. (Prices on request.)

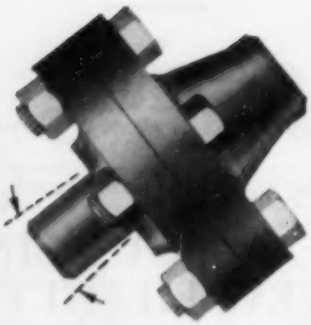
Units may be coupled for fractionation. The distributor acts to accelerate the distillate through the evaporator—residence time is less than one second.

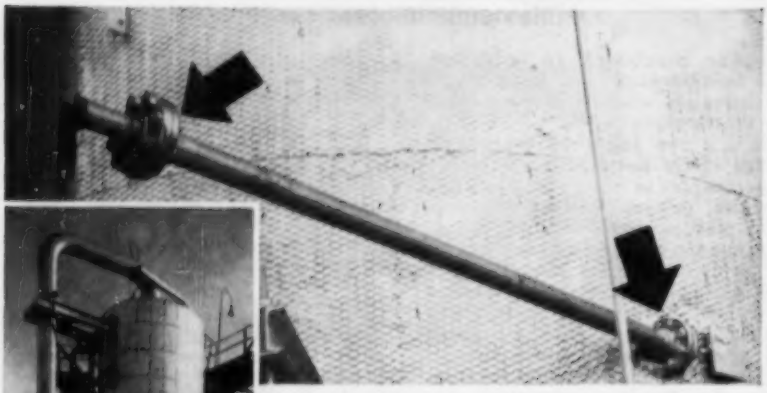
In many installations of both the laboratory model and the Twelve Inch Pilot Plant unit, the versatility and high evaporation rate of this new evaporator have been proved. And it has been found that the quality of results from these small units can be dependably duplicated in production size units.

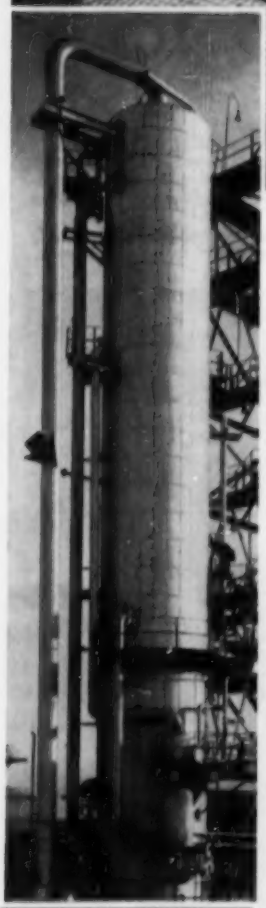
It's easy to test your distillant yourself with the laboratory model. Data you gather will enable you to uncover those areas of greater profit in your own operation. For your needs at that time, Pfaudler offers standard jacketed units in 24-, 36-, 48-, and 60-inch production size models.

*Order the Pfaudler Two Inch Laboratory Evaporator now.*

# HERE'S HOW
Plant Engineers and Builders Use
# BARCO FLEXIBLE STRUT JOINTS







## —for Structural Applications

Barco Flexible Strut Joints are an important aid in chemical and petrochemical plant construction. A typical use is at the ends of struts for supporting or bracing large catalyst carrier lines or vent stacks on fluid catalytic crackers. In such cases, where horizontal lines require supports, two braces (with Barco Strut Joints in each) make costly "A" frames unnecessary. Other uses include guying tall vessels and columns and directing thermal movements of high temperature piping.

**SIMPLE, VERSATILE!**—The Barco Strut Joint is a dependable, compact, versatile fitting requiring practically no maintenance. It is a simple ball and socket that provides a point of flexibility. The close fit between ball and casing, allows for reversible loads, not possible with pin and clevis type braces. Barco Strut Joints support without restricting freedom of movement.

**COMPLETE LINE**—Available in following sizes and capacities: 1"—8,500 lbs., 1½"—14,500 lbs., 2"—20,000 lbs., 3"—40,000 lbs., 5"—80,000 lbs., 6"—120,000 lbs., Welding ends for field or shop use. Unique "Bar-Moly" treatment of wearing parts provides permanent dry lubrication for long service.

**ENGINEERING SERVICE**—Barco will be glad to work with your engineers in the selection of joints to meet your requirements. *Specifications and information on request.*

SEND for your copy of interesting new illustrated bulletin No. 28 showing PETROCHEMICAL AND PETROLEUM INDUSTRY applications for Barco Ball, Swing, and Strut Joints.

**BARCO** *Manufacturing Co.*

560K Hough Street • Barrington, Illinois


## About our authors

(*Continued from page 66*)

**C. Rogers McCullough,** who authored a *C.E.P.* nuclear paper about a year ago, has been made Deputy Director for Hazards Evaluation in AEC's Div. of Civilian Application. With Monsanto since 1928, Rogers has been active in the nuclear program for years. He will direct the development of criteria and standards for safe design and operation of nuclear facilities and the evaluation, from a safety standpoint, of individual projects proposed to be constructed either by private industry under license or by the AEC.

The *New York Times* has carried a feature story telling of what nine young men have done in forming a company through which to offer their consulting skills in the nuclear field. Called "Radiation Applications, Inc.," six of the organizers are under 35 and the oldest is 47. Among this group are *C.E.P.* authors **Elmer Gaden, Jr.** (articles on fermentation) and Ernest J. Henley, who has recently written for "Marginal Notes."

**D. J. Hughes,** who prepared for *C.E.P.* the critique on the Russian Kurchatov's Harwell lecture on thermonuclear reactions (page 134), was director of nuclear physics at Argonne until 1949, when he became senior physicist at Brookhaven. In commenting on Kurchatov's unprecedented talk, Hughes states, "My general reaction is that it was a typical high-level technical talk, honest and straightforward, and not an attempt to convey the impression of releasing information without really doing so. Many detailed numbers are given in connection with the experiments described and this detail would not be necessary if the desire were simply to create an impression. Such, and other, matters lead me to believe that in this particular field, they are releasing the great bulk of their basic work.

"It is of particular importance that the thermonuclear report represents the first time that the Soviets have released information ahead of us. In the past their releases have always followed ours, but in this case they have jumped very far ahead of us.

"Then too, we should keep in mind that the information contained in Kurchatov's talk has little to do with our relative positions as far as technical accomplishments in the field are concerned; this latter matter is difficult to discuss, of course, because of the high classification status of our own work."

# NOW

# prilled ammonium nitrate-via the Stengel Process

The new type ammonium nitrate is produced in a compact C & I-designed and built plant using a cooling chamber approximately one-fifth the size of conventional prilling towers. Capital investment is about 25% less than that required for old type prilling plants of comparable capacity. The modified Stengel Process does not require dryers, yet produces a superior prill of uniform size with about .02% moisture content. The high density of the product allows it to be stored in a minimum space without the danger of caking and assures easy application.

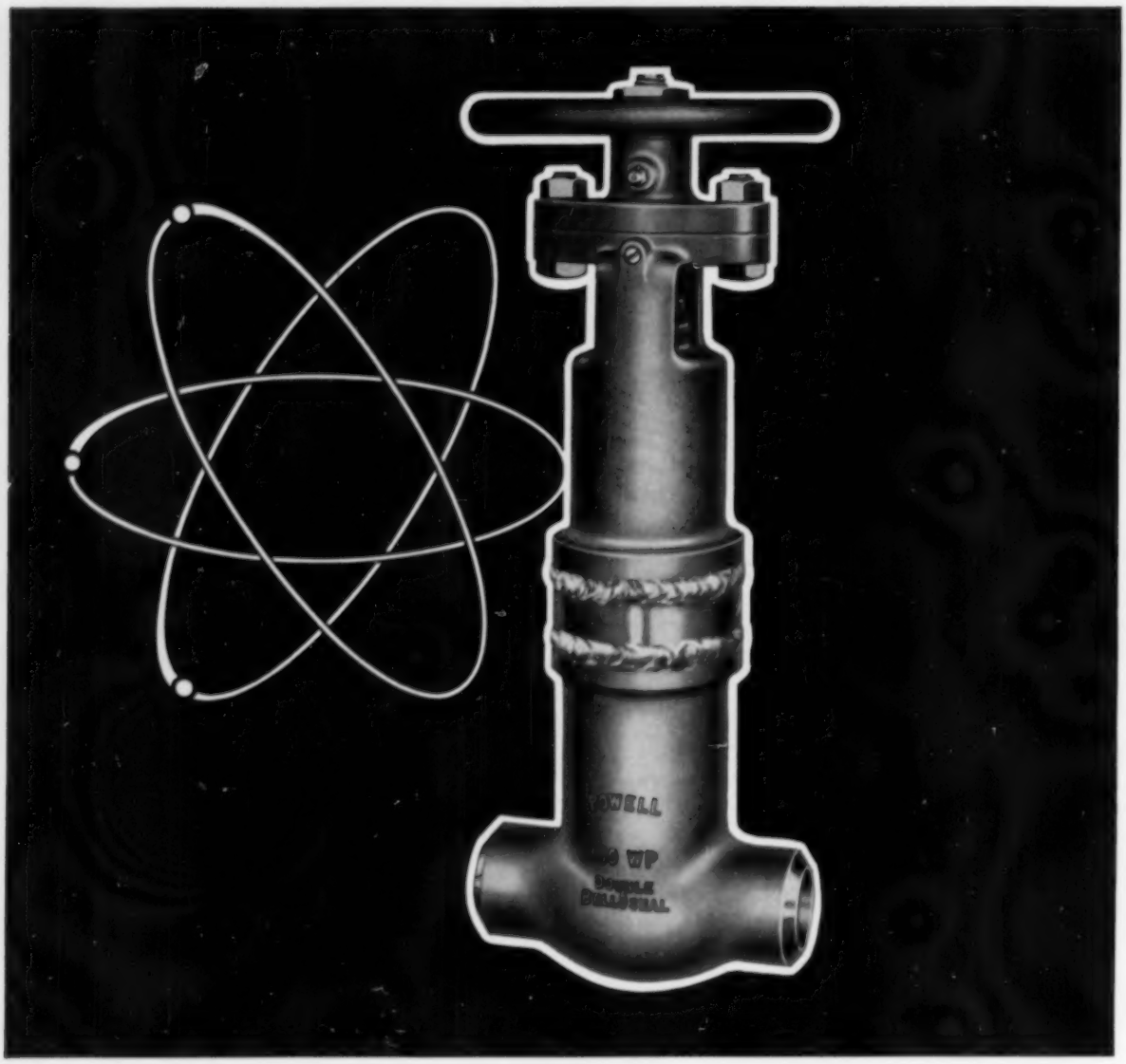
C&I

THE CHEMICAL AND INDUSTRIAL CORP.

CINCINNATI 26, OHIO

Designers and Builders of Plants for the Processing of Ammonia—
Available Throughout the World

NITRIC ACID • PHOSPHORIC ACID • AMMONIUM NITRATE
COMPLEX FERTILIZER • AMMONIUM PHOSPHATE




# Precision-made packless valves...

*. . . designed specifically for use with heavy water, molten metals and radioactive coolant service, receive special attention at Powell.*

Only the finest materials are used in these nuclear valves, and painstaking quality control is rigidly enforced through each step of manufacture. For example, every machining operation is accurately gauged. All parts are thoroughly cleaned and degreased. And every nuclear valve is given an actual line test . . . *plus* a snifter or mass spectrometer test.

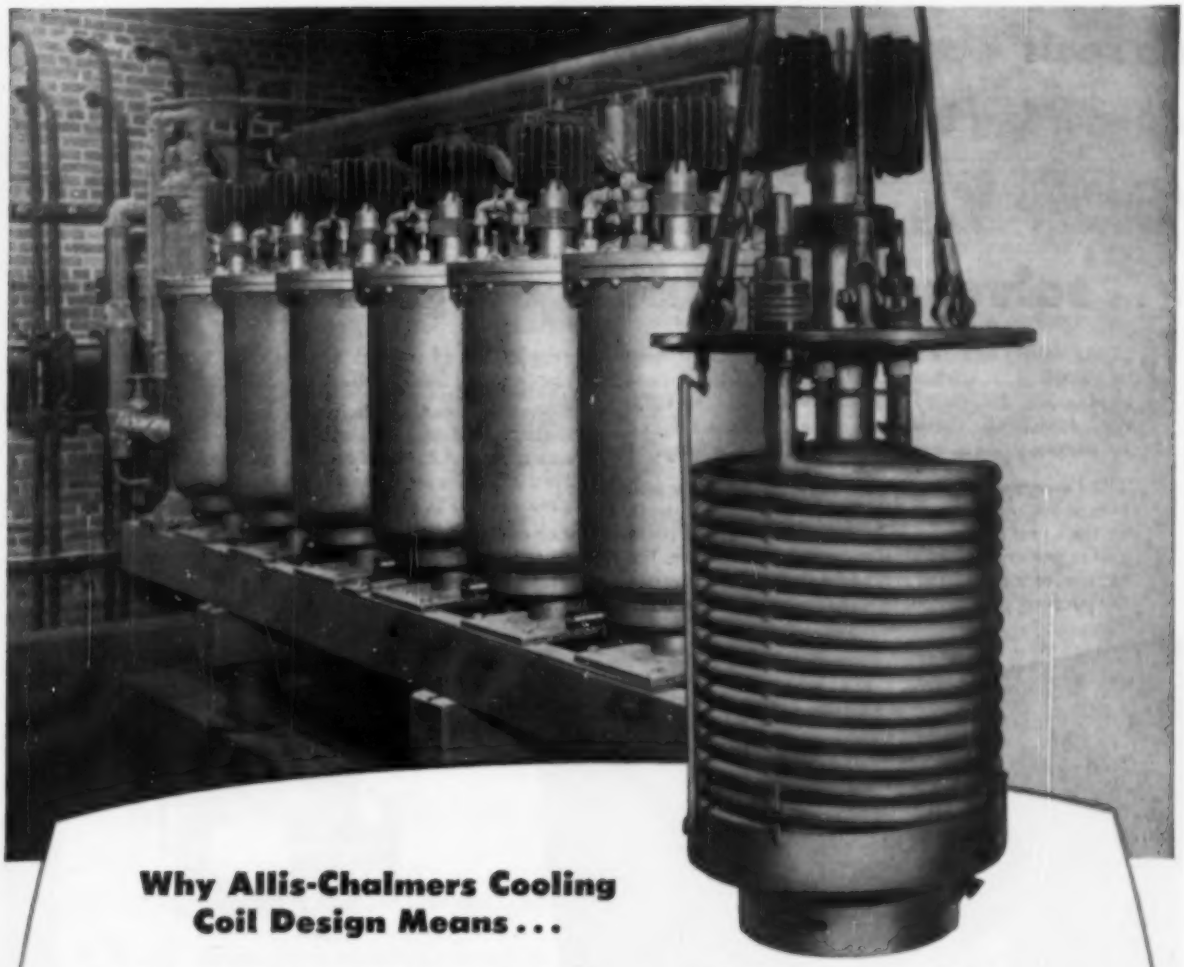
Illustrated here is a double bellows BELL-O-SEAL Valve available to industry for use with heavy water, molten metals and radioactive coolant service. For complete information, consult your Powell Valve distributor. If none is near you, we'll be pleased to tell you about our Nuclear Valves as well as our *complete line* of *Powell Quality Valves*—all with *Performance Verified.*

PERFORMANCE PV VERIFIED

**The Wm. Powell Company, Cincinnati 22, Ohio . . . 110th YEAR**

# POWELL VALVES

BRONZE, IRON, STEEL AND CORROSION RESISTANT VALVES.



**Why Allis-Chalmers Cooling Coil Design Means . . .**

# Better Rectifier Operation

**More Efficient Heat Transfer** results from internal cooling coil. The steel coil surrounds active parts, offering more cooling surface and better heat transfer than other types. Unit maintains more uniform temperature and mercury vapor pressure.

**Simplified Maintenance** results from Allis-Chalmers unique unit construction. All active components are attached to the anode plate for easy withdrawal, dismantling, and re-assembling — as illustrated above.

**Positive Arc Barrier** is formed by the cooling coil, which is insulated from the tank. The main arc is confined within the coil, preventing arc transfer to the tank.

**Years of Operation** in hundreds of installations have proved the reliability, ease of operation, and simplified maintenance of Allis-Chalmers mercury arc rectifiers. You can get complete information at your nearby A-C office, or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.

LIVE BETTER ELECTRICALLY

**ALLIS-CHALMERS**

A-C ALLIS-CHALMERS

A-5084

**no seals**

**no stuffing box**

***no leakage***

# Chempump

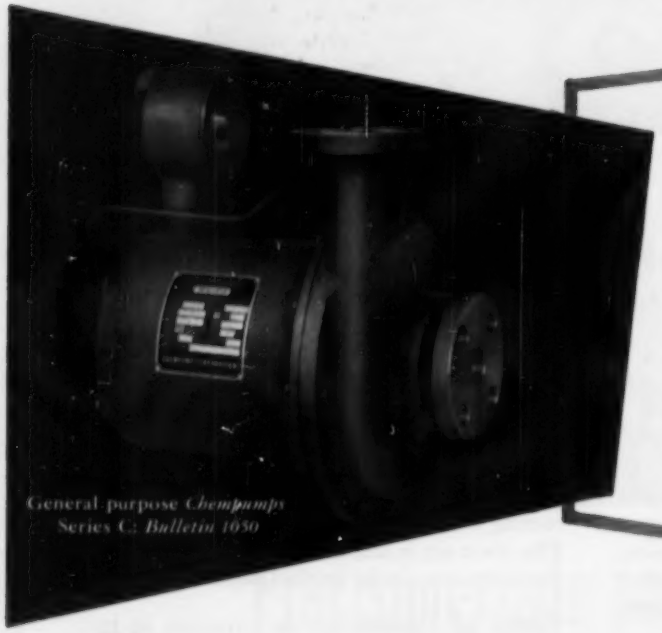
# . . . solves the problem of "problem" fluids

Name your problem fluid, and there's a *Chempump* to handle it . . . without a chance of leakage or contamination. Normally hard-to-handle fluids—volatile, toxic, corrosive, explosive, radioactive, or sensitive—present no problem with *Chempump.*

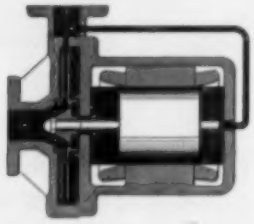
The *Chempump* is totally enclosed. Both motor and pump are combined in a single hermetic unit. There's just one moving part—the combined rotor and impeller. No packing to "nurse" or replace. No expensive mechanical seals to fail. No shaft wear in the packing gland. And external lubrication is never required . . . bearings are constantly lubricated by the pumped fluid itself.

*Chempump* is available in a wide choice of materials including Monel, Hastelloy B and titanium. Capacities range to 250 gallons per minute; heads to 195 feet. Handles fluids at temperatures to 1000°F and pressures to 5000 psi.

For complete details, write to Chempump Corporation, 1300 East Mermaid Lane, Philadelphia 18, Pa. Engineering representatives in over 30 principal cities in the United States and Canada.



General-purpose *Chempumps* Series C: *Bulletin 1050*



***Secret of the Chempump is the combined construction of pump and motor. Radial magnetic drive actuates a standard hydraulic impeller connected to an induction motor rotor. Pumped fluid circulates freely through rotor chamber of motor, isolated from stator windings by a corrosion-resistant, non-magnetic alloy liner inserted in air gap. Rotor is canned with same alloy. U.L. approved.***

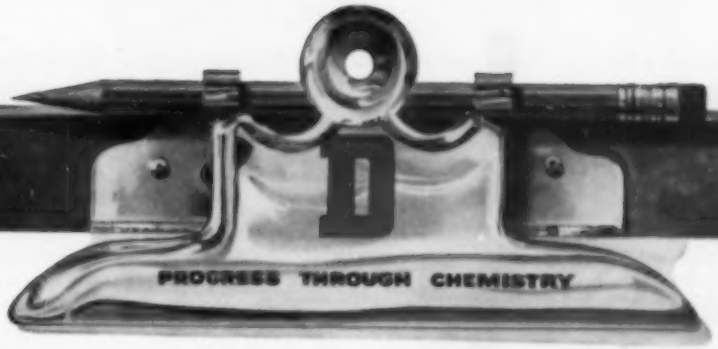
Two-stage *Chempumps* Series DE: *Bulletin 1020*

Low capacity *Chempumps* Series E: *Bulletin 1060*

High temperature *Chempumps* Series T: *Bulletin 1040*

Low-cost *Chempumps* Series S: *Bulletin 1030*

***Chempump* — first in the field—process proved**




# Announcing

## Expanded Rare Earths and Thorium program

### of Davison Chemical and Rare Earths, Inc.

**Davison Chemical Company, Division of W. R. Grace & Co., and Rare Earths, Inc., Pompton Plains, N. J., a wholly-owned subsidiary of Grace, have joined in a program of expanded production, sales, research and development of thorium, cerium and other rare earths compounds.**

Rare Earths, Inc., organized in 1947 for the production of Rareox, an optical quality cerium oxide polishing powder, has diversified into thorium, cerium and other rare earth chemicals. Now, additional facilities are being installed at Davison's Curtis Bay (Baltimore) plant. This means added service plus intensified research and development.

Current applications, in addition to thorium as a potential source of atomic energy, are glass polishing, glass coloring and decolorizing, as a component in carbon arc electrodes, in lighter flints, and for ferrous and non-ferrous metallurgical alloys.

Rare Earths, Inc., an affiliate of Davison Chemical Company, Division of W. R. Grace & Co., offer a quality line of thorium and rare earth chemicals. Contact your Davison Sales Office for additional information on these interesting and useful products.

**DAVISON CHEMICAL COMPANY**

*Division of W. R. Grace & Co.*

**Baltimore 3, Maryland**

Sales Offices: Baltimore, Md.; Chicago, Ill.; Columbus, Ohio; Houston, Texas; New York, N. Y.

Producers of: Catalysts, Inorganic Acids, Superphosphates, Triple Superphosphates, Phosphate Rock, Silica Gels, Silicofluorides. Sole producers of DAVCO® Granulated Fertilizer.

# HOUDRY SILICA ALUMINA CATALYSTS

**For chemical reactions requiring a catalyst or catalyst carrier with acidic properties**

For maximum process economy, Houdry offers a wide variety of Silica Alumina Catalysts which are manufactured to rigorous standards to provide optimum activity, selectivity, stability and mechanical strength.

These materials are produced in varying activities, surface areas and acid functions to meet numerous chemical needs.

Among the many applications requiring a silica alumina catalyst or an acidic-base carrier are:

**ALKYLATION • CRACKING • DEALKYLATION**

**ESTERIFICATION • ISOMERIZATION • HYDROGEN TRANSFER**

**POLYMERIZATION**

# HOUDRY

**PROCESS CORPORATION**

1528 Walnut Street, Philadelphia 2, Pa.

***Pioneer in Catalysis***

Houdry will manufacture to specification and will assist in developing catalysts to meet special requirements.

Write for detailed information on Silica Alumina Catalysts and many other types.

The future course of the program for building atomic reactors to produce electric power in this country may be greatly affected by the outcome of the elections. The Republican administration has fostered the building of reactors by private enterprise. About ten privately built power reactors are now definitely projected, but there has been a good deal of criticism (in Washington and elsewhere) of the slowness of the job.

In the event of a Democratic victory or of a Democratic Congress, there would almost certainly be a drive, as advocated in their platform, for a program by the government to build reactors on the grounds that private industry has been lagging and that it is reluctant to spend the money at a time when it appears that atomic power is economically not competitive with other sources of power.

The Gore bill, introduced by the Senator from Tennessee at the last Congress, provides that the government finance six additional power reactors at six locations around the country. Although this is probably not the solution to the problem, Congress is deeply interested, so legislation of some sort may be looked for at the next session. Some authorities believe the best solution would be a cooperative effort by both government and private industry.

### Economics of Atomic Power

Perhaps explaining some of the congressional interest is the announcement made recently at the World Power Congress in Vienna that Great Britain is ahead of us and also ahead of Soviet Russia in building and operating economically efficient reactors. Sir John Cockcroft, head of Britain's Atomic Energy Authority, has said that Britain will be able to produce power costing 7 mills per kilowatt hour at its Calder Hall reactor which will soon be running, delivering by next year about 65,000 kilowatts.* Contrast this with the statement by Admiral Rickover that the Shippingport reactor being built by the Westinghouse company will have an initial power cost of 52 mills which may later be reduced to 39 mills. Costs of this sort indicate why private industry may have some hesitation about going ahead too fast.

Cockcroft also points out that, although the Russians have been aggressive in developing reactors, their large unused sources of water power make it unlikely that they will actually build many atomic power plants for their own use. He takes this position also with respect to the so-called undeveloped countries, which, in almost every case, have available resources of cheap fossil fuel or of water power, against which nuclear power would be uncompetitive. Japan is among another group, however, for whom present power costs are high enough to offer a good market for reactors, which should offer interesting competition between ourselves and the British.

Labor is also becoming extremely "atom conscious" and is concerned about radiation hazards to workers, which will mean the unions will plug for insurance and perhaps safety regulations. They can also be counted on to ask for wage premiums in atom plants and in reactor power plants to compensate for extra risks.

Congress probably will be asked to provide help for an insurance program which would get industry squared away. There will also be efforts to increase and encourage production of atomic fuels which will help uranium and uranium miners.

### Indirect Effects of Atom Research

Meanwhile, evidence is accumulating of practical results in other fields owing to the widened scientific knowledge created by studies of the atom, of its particles, and of radiation and its effects. Leading chemical and electrical firms are actively interested.

Uses for new materials have been uncovered. Atomic interest in some of the newer metals and especially in super-purified metals is spreading to other fields, with practical results in the offing. Research in the use of radiation to speed up chemical reactions is increasing.

Heightened interest in the new fields is shown by plans of the Du Pont Company to build a $2,000,000 radiation physics laboratory to study the effects of radiation on materials.

Union Carbide & Carbon Corp., through its nuclear division, has been running Oak Ridge for years but has never been one of the firms that evinced any immediate interest in power reactors. Now, however, the firm has announced plans for a large laboratory in Parma, Ohio, with the primary purpose of studying the comparatively new science of solid state physics, which may be considered in part an offspring of the new knowledge of the atom.

As a result of this research program, Carbide has already developed a new transistor made of pure silicon metal which can operate at higher temperatures than germanium transistors—a discovery which should be valuable in some of the newer military equipment.

Concentrated research will be done on catalysts in an effort to unravel the still-mysterious functions of these agents. Work is also being done on inter-metallic compounds such as indium antimonide. The number of possible new compounds between metals and nonmetals is enormous and is believed to be of great potential importance.

* C.E.P. received the following verification from J. V. Dunworth of the U.K.A.E.A.: "In reply to your cable, the United Kingdom Atomic Energy Authority believes that the first U. K. civil nuclear power station will compete with coal-produced power."

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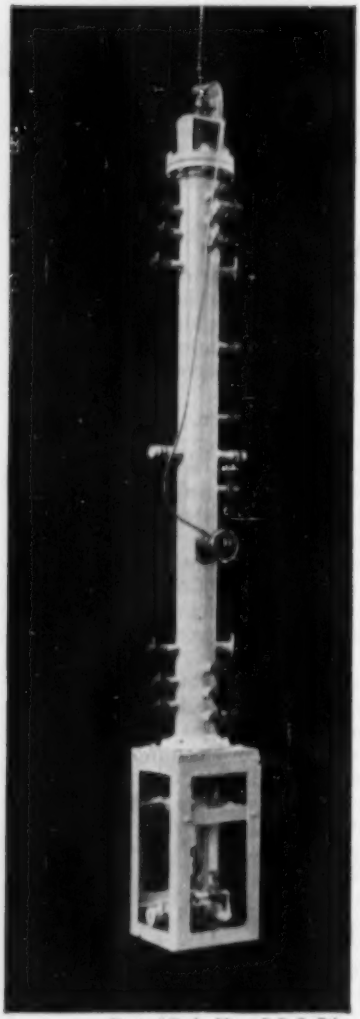

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CEP

# opinion and comment

R. P. Genereaux

H. S. Isbin

G. F. Jenkins

M. C. Leverett

F. J. Van Antwerpen

## Nuclear Milestone

THIS issue of CEP, called a "special issue" because of its concentration largely on a single subject, possesses certain qualities which should be brought to the reader's attention.

Inasmuch as the subject is nuclear engineering, we have done some rather careful selecting to put together material representative of the chemical engineer's role and interest in the field of this new energy source, *circa* mid-1956.

While ranging as far afield as the lecture halls of Harwell, the laboratories of Russia, and the meeting chambers of the World Power Conference at Vienna, we have of course obtained most of our material from within the boundaries of our own nation. Much aid has come from the Atomic Energy Commission.*

We have endeavored to get together timely reports for our readers on subjects which, though not directly related to technology, still bear heavily on the environment in which the chemical engineer is and will be functioning with respect to nuclear energy. We have touched on the problem of secrecy, how to get the various kinds of information to which one might be entitled, risk insurance, legal aspects, and advanced training.

To determine what the technical article structure should be, we turned for assistance to the Nuclear Engineering Division. The problem of rating nuclear papers for importance of contribution, timeliness, application potential, and other qualities is quite different from that of more conventional papers, partly due to the fact that they originate from material still classified. Since security policies require some compartmentalization of activity and consequently of knowledge, the locating of qualied specialists was difficult.

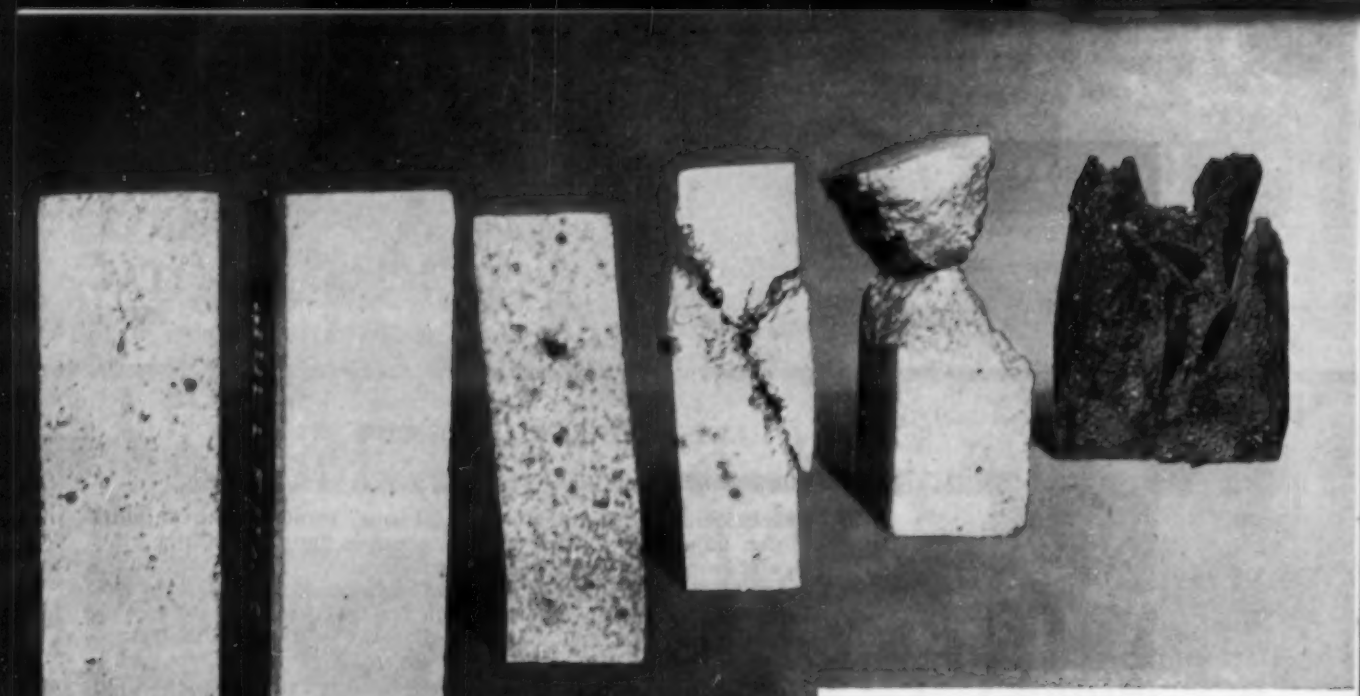
This was solved by the appointment of a special *ad hoc* advisory committee, made up of Miles Leverett, G. E., chairman of A.I.Ch.E. Nuclear Engineering Division; Ray Genereaux, DuPont, past chmn., Nuclear Eng. Div.; Herbert Isbin, U. of Minn., vice chmn., Nuclear Eng. Div.; George Jenkins, Union Carbide Nuclear, mbr. Nuclear Eng. Div.; and F. J. Van Antwerpen, A.I.Ch.E. staff, and member of Industrial Information Advisory Committee, A.E.C. This group undertook the responsibility as individuals of selecting the best pattern of papers for publication out of twenty or so possibilities assembled.

Herbert Isbin took a strong role in the early planning for the issue. General counselling and detailed reviewing of the papers was undertaken by George Jenkins, who also had recourse to qualified specialists throughout the country, and thus mobilized practical recommendations which in all cases were well received and adopted by the authors.

The time and effort put in by these people was such that this acknowledgment is but small reward for their efforts, and they obviously performed the service because they believed in the importance of communicating the information selected to the members of the profession. It is such spirit that has made the Institute and the Nuclear Division vital factors in securing the future of our profession.

—J.B.M.

* Credit is due also to the following individuals and organizations: In the A.E.C.—Edward Brunenkant, Asst. Dir. of Public Information; Wilbur Strausser, Asst. Dir. of Classification; and H. L. Walker, Education and Training Specialist, Civilian Power Reactors Branch. Also—D. J. Hughes, Brookhaven National Laboratory; Mathew M. Braidech, National Board of Fire Underwriters; and R. J. Klotzbach, Asst. Dir. of Eng., Union Carbide Nuclear Co.



Comparison of hot strength at 1720° C and 25 psi shows CARBOFRAX® silicon carbide brick undeformed on extreme left, MULLFRAX® brick with only 1.4% contraction, ordinary refractories in various stages of deformation. The one on extreme right failed at 1650° C.

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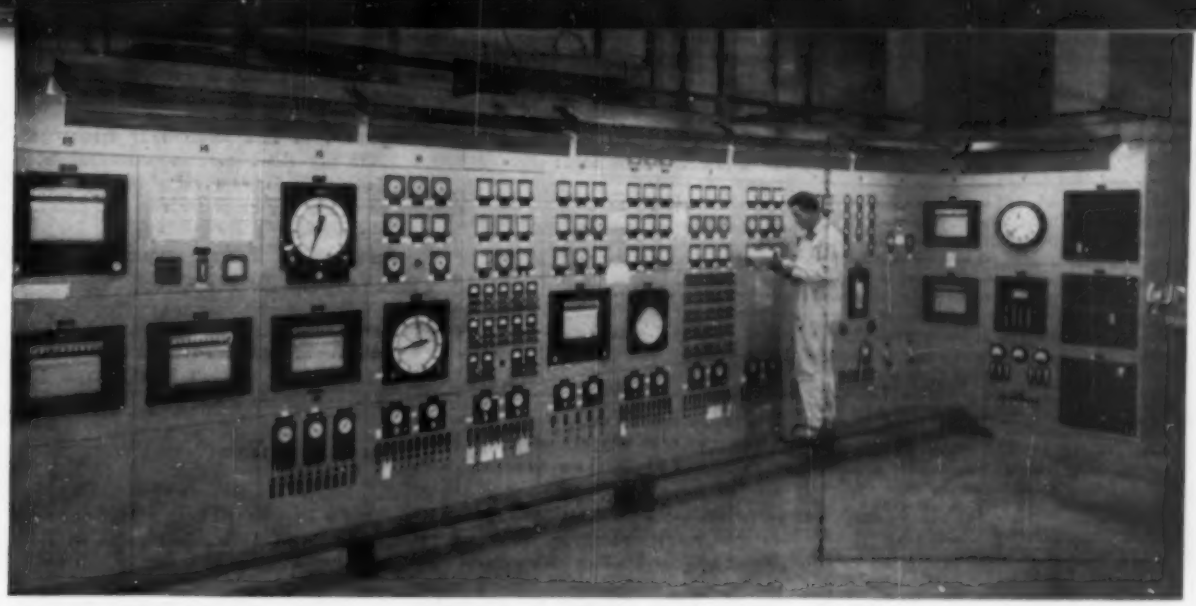


Fig. 5. Thorex instrument panel.

# CHEMICAL PROCESSING OF AQUEOUS BLANKET AND FUEL FROM THERMAL BREEDER REACTORS

*F. R. Bruce* | Oak Ridge National Laboratory, Oak Ridge, Tennessee

**Processing of the aqueous thermal breeder blanket and fuel is especially interesting from the chemical engineering viewpoint since the fluid state of the fuel and blanket makes it possible to achieve all the processing objectives with minimum alteration to the fuel and blanket. In the discussion which follows, the principles of thermal breeder reactor fuel and blanket processing will be presented, and flowsheets for a three-reactor power station described.**

The two-region thermal breeder (TBR) represents a reactor type whose development is being pursued most vigorously in the United States nuclear power program (*1, 2*). It employs uranyl sulfate, contained in a zirconium tank, as fuel. The zirconium core tank is surrounded by a blanket of thorium oxide, suspended in heavy water and contained by a stainless steel-clad pressure vessel. Table 1 presents the characteristics of the specific reactor whose processing will be described.

During reactor operation a number of events occur which make chemical processing necessary:

1. While $U^{235}$ is being consumed for heat production in the core, a slightly greater quantity of $Pa^{233}$, which decays to $U^{233}$, is produced in the blanket. Most of this $U^{233}$ must be removed from the blanket and returned to the core as fuel; the balance represents the breeding gain. At the same time, the thorium blanket material must be purified from corrosion and fission products which accumulate.

2. Fission products are produced in the reactor core and, as a result of corrosion, zirconium, iron, chromium, nickel, and manganese are introduced into the system. Many of the fission products and corrosion products have high cross sections and impair the neutron economy of the reactor. They must, therefore, be removed.

3. Some of the contaminants produced in the core are insoluble under reactor conditions. Among the fission products the rare earths, strontium, barium, zirconium, and niobium fall in this category; the corrosion products zirconium, iron, and chromium precipitate. Since the presence of these insolubles may complicate reactor operation, it is desirable to purge them from the core.

4. Finally, the fission products constitute a health hazard in the event of a catastrophe, and they should therefore be removed from the reactor system and isolated in such a form that they cannot be released to the environment.

## Core Processing

### POISONING

Neutron losses to extraneous materials in a reactor fuel or blanket are conveniently described by the term

$$\% \text{ poison} = (100)\frac{\Sigma p}{\Sigma f} \qquad (1)$$

where

$\Sigma p$ = total macroscopic cross section of poison/unit volume (sq.cm.)

$\Sigma f$ = total macroscopic fission cross section of the $U^{235}$/unit volume (sq.cm.)

If a reactor operates for an extended period of time, the per cent poison, which is a measure of neutron and hence fissionable material losses, increases (Figure 1), with the rare earths and the corrosion products contributing heavily to the poisoning.

### BEHAVIOR OF FISSION AND CORROSION PRODUCTS UNDER REACTOR CONDITIONS (3)

The poisons encountered in a homogeneous reactor core may be conveniently divided into the following categories: the insolubles; the gases; and the solubles. Table 2 shows the solubility of those materials which have limited solubility. The rare earths, iron, and chromium, all of which are important poisons,

**ACKNOWLEDGMENT**

This paper is based on the work of a large number of people in the Chemical Technology Division of the Oak Ridge National Laboratory. Much of the detailed work remains classified, and it has not been possible to refer to it in the references. The author wishes especially to recognize this group of individuals for their contributions, including: A. T. Gresky and E. D. Arnold for calculating the poisoning effects of fission and corrosion products; W. H. Carr and E. M. Shank for development of large-scale methods for preparing thorium oxide; and R. J. Klotzbach, E. D. Arnold, A. T. Gresky, and A. R. Irvine for their conceptual design of a homogeneous reactor chemical processing plant.

exhibit very low solubility in uranyl sulfate solution at elevated temperatures, and may be removed from the reactor by a solid-liquid cyclone, commonly called a hydroclone (*4*).

Fuel solution, containing suspended solids, is removed from the high-pressure side of the reactor core heat exchangers and sent to the hydroclone. Clarified overflow from the hydroclone is returned to the low-pressure side of the heat exchangers, while the solids collect in the hydroclone underflow receiver, a vessel mounted below the hydroclone and connected to its underflow port (*5*).

The rare gases xenon and krypton will be removed from the reactor with radiolytic deuterium and oxygen, which are sent to the recombination system. If copper is employed as an internal catalyst for complete radiolytic gas recombination, other methods for removing krypton, xenon, and iodine must be used.

Iodine chemistry under reactor conditions (280° C.) is indicated by the reaction

$$IO_3^-{}_{(l)} \rightleftharpoons I^-{}_{(l)} \rightleftharpoons I^\circ{}_{(g)}$$

In 0.02 M $UO_2SO_4$–0.005 M $H_2SO_4$, the following ratios hold:

$$\frac{[I^\circ{}_{(l)}]}{[IO_3^-{}_{(l)}]} = 7$$

and

$$\frac{[I^\circ{}_{(g)}]}{[I^\circ{}_{(l)}]} = 7.$$

In $D_2O$ at $p$H 4 to 9,

$$\frac{[I^\circ{}_{(g)}]}{[I^\circ{}_{(l)}]} = 0.2.$$

Design studies show that an attractive iodine removal process may be based upon stripping it from the fuel with oxygen at reactor temperature and pressure, followed by backstripping into water. Since iodine is a significant poison and the leading radiological hazard in the reactor, considerable attention is being devoted to developing methods for removing it.

Soluble poisons—cesium, nickel, and manganese—will be removed from the core system when the hydroclone underflow receiver containing the solids suspended in fuel solution is discharged.

If the TBR core is processed on a daily cycle for removal of insolubles and on a 190-day cycle for removal of soluble poisons, a poison level of 5.6% is maintained. Table 3 summarizes TBR poisoning when such a processing scheme is employed. Achieving this poison level without daily solids removal by withdrawing an aliquot of fuel for purification would necessitate processing the core on a 55-day cycle.

## HAZARDS REDUCTION (6)

Continuous processing of TBR fuel results in a substantial reduction in the radiological hazard associated with the system. In evaluating the hazard reduction, the term "relative hazard" may be used. The relative hazard for each radioisotope is arbitrarily defined as the exposure contributed by the isotope in a reactor accident divided by its permissible biological tolerance. Table 4 shows the relative hazards of several radio-

**Table 4.—Biological Hazards Associated with Reactors under Two Operating Conditions and the Hazard Reduction Obtained by Continuous Removal of Fission Products**

| Isotope | Relative hazard for 80-day operation, $\times 10^{-4}$ | Relative hazard for 1-day processing cycle, $\times 10^{-4}$ | Reduction in hazard by continuous processing |
|---|---|---|---|
| $I^{131}$ | 375 | 32.5 | 11.5 |
| $Ba^{140}$—$La^{140}$ | 165 (110 to bone) | 8.94 (6.0 to bone) | 18.5 |
| $Sr^{89}$ | 145 | 3.01 | 48 |
| $Ce^{144}$—$Pr^{144}$ | 140 | 1.86 | 75 |
| $Y^{91}$ | 85.5 | 1.68 | 51 |
| $Nb^{95}$ | 36.4 | 2.22 | 16.4 |
| $La^{140}$ | 33.0 | 1.79 | 18.5 |
| $Pr^{144}$ | 30.5 | 1.53 | 20 |
| $Te^{129}$ | 25.0 | 0.67 | 38 |
| $Sr^{90}$—$Y^{90}$ | 15.0 | 0.19 | 80 |
| $Ce^{142}$ | 13.4 | 0.35 | 39 |
| $Mo^{99}$ | 10.3 | 2.2 | 4.7 |
| | 1,070 | 57 | 18.8 |

Fig. 1. Total poison effects in core of two-region thermal breeder.

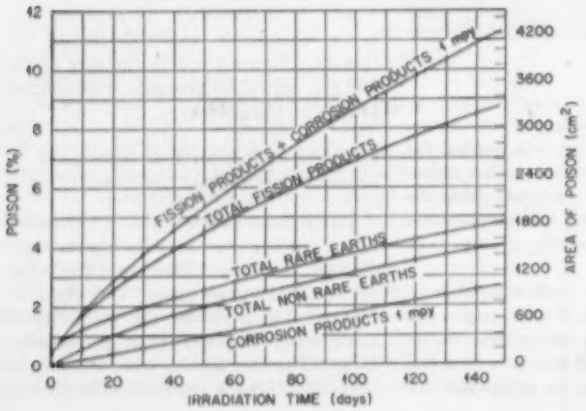



Fig. 7. Thorex sampler in sampling position.

**Table 1.—Characteristics of Two-region Thermal Breeder Reactor**

| | Core system | Blanket system |
|---|---|---|
| Power, Mw. | 320 | 144 |
| Volume, liters | 23,000 | 21,000 |
| Avg. flux, $n/(sq.cm.)(sec.)$ | $3.2 \times 10^{14}$ | $5.1 \times 10^{13}$ |
| Thorium, g./liter | | 1,000 |
| $U^{233}$, g./liter | 1.24 | 5 |
| $Pa^{233}$, g./liter | | 1 |

**Table 2.—Elements of Limited Solubility in TBR Fuel**

| | Solubility at 280° C., mg./kg. $D_2O$ |
|---|---|
| $La_2(SO_4)_3$, $Ce_2(SO_4)_3$, $Pr_2(SO_4)_3$, $Nd_2(SO_4)_3$, $Y_2(SO_4)_3$ | 85 |
| $SrSO_4$, $BaSO_4$ | 10 |
| $ZrO_2$, $Nb_2O_5$, $Fe(OH)_3$, $Cr(OH)_3$ | 5 |
| Ru, Rh, Pd | 5* |

* The chemical nature of the insoluble compounds of this group is not known with certainty.

**Table 3.—TBR Core Poisons ***

| | % Poison |
|---|---|
| **Limited solubility** | |
| Nd | 0.8 |
| Ce | 0.2 |
| Sm, Eu | 0.8 |
| Ba, Sr | 0.1 |
| **Gases** | |
| Kr, Xe | 0.5 |
| I | 0.1 |
| **Solubles** | |
| Cs | 1.3 |
| Ni, Mn | 0.6 |
| Tc | 1.2 |
| Total | 5.6 |

* Daily processing cycle through hydroclones and 190-day processing cycle through Thorex.

Fig. 2 (top). TBR chemical processing flowsheet.
Fig. 3 (bottom). TBR chemical processing plant.

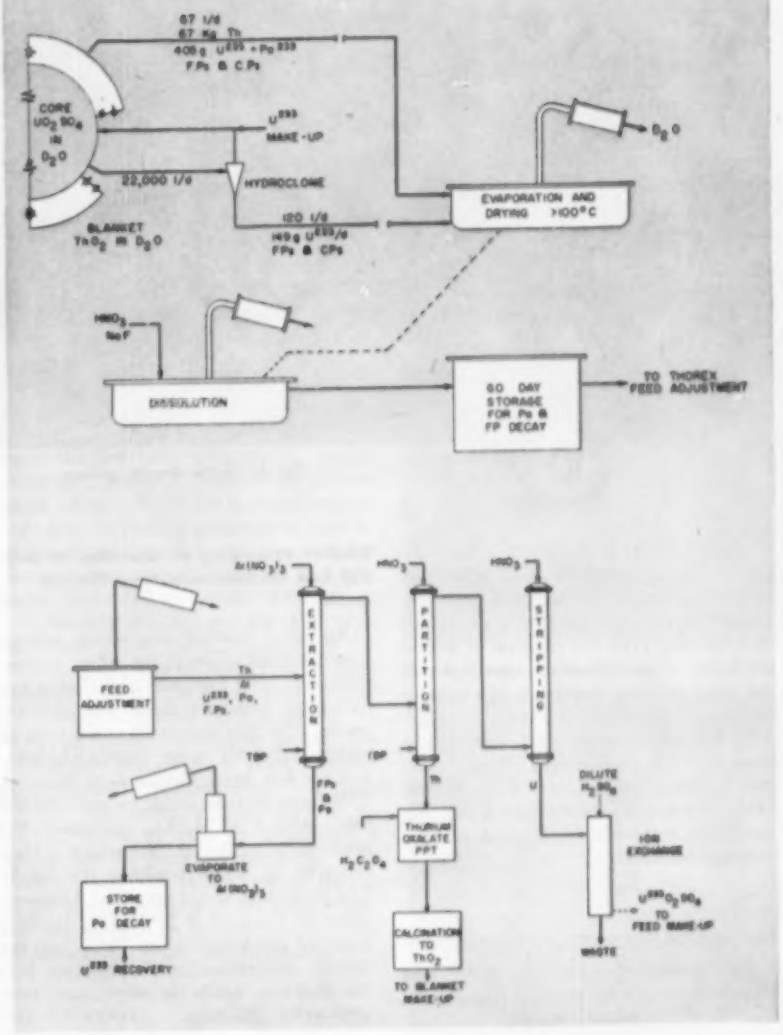
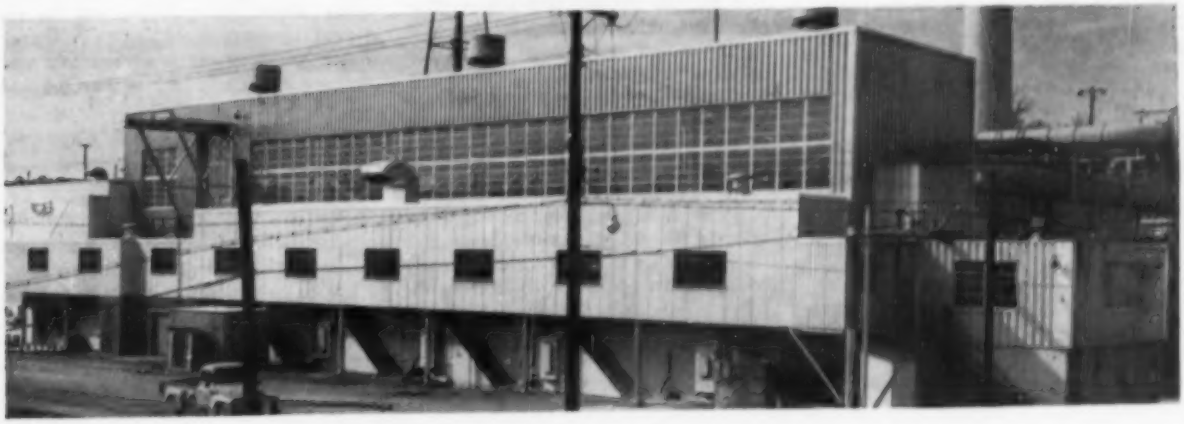



Fig. 4. Thorex pilot plant 3019 building.



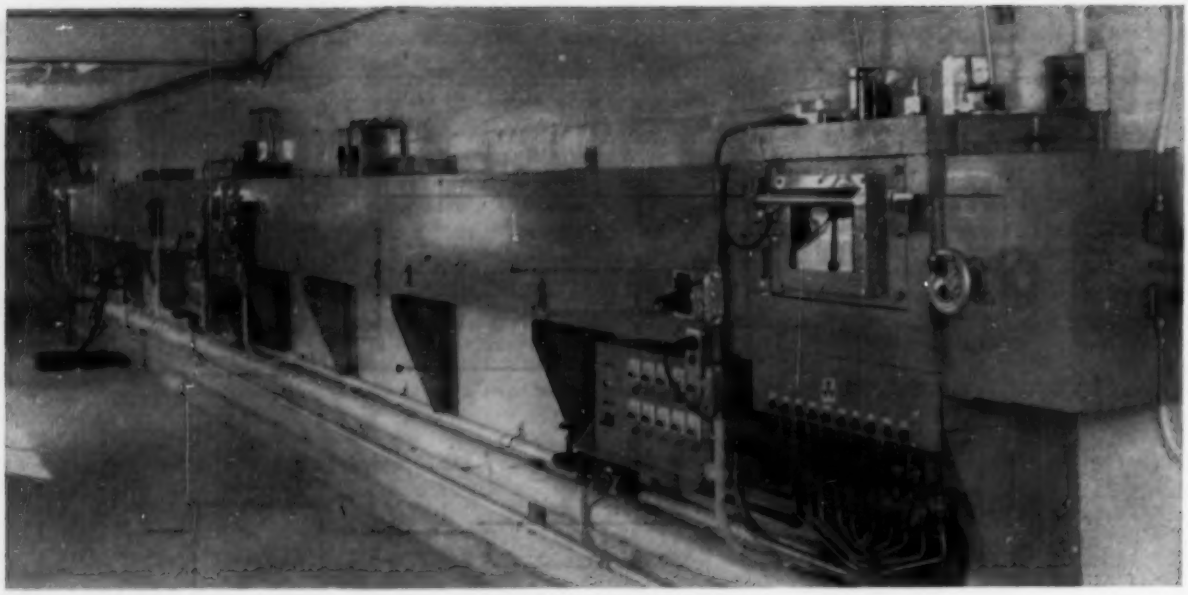


Fig. 6. Thorex sampler gallery.

isotopes. It is first assumed that the reactor has operated for 80 days without processing before an accident, and secondly, that the reactor fuel is processed on a one-day cycle for removal of fission products. Approximately one third of the total relative hazard is attributable to iodine. With the exception of tellurium and molybdenum, the rest of the hazard is due to fission products which are insoluble under reactor conditions. If the reactor is processed on a one-day cycle, the total relative hazard may be reduced 18.8-fold.

**Table 5.—Contributions of Core and Blanket Material to Solvent Exposure in the Thorex Process**

Core processing period: daily through hydroclones; 190 days through Thorex

Blanket processing period: 320 days

Solvent exposure: 10 min. in extraction column

| Decay time, days | Solvent exposure, $\beta$ watt-hr./liter | |
|---|---|---|
| | From core material | From blanket material |
| 5 | 3.66 | 0.82 |
| 10 | 2.63 | 0.72 |
| 20 | 1.67 | 0.58 |
| 30 | 1.17 | 0.55 |
| 40 | 0.89 | 0.36 |
| 50 | 0.70 | 0.29 |
| 60 | 0.56 | 0.23 |
| 70 | 0.49 | 0.18 |
| 80 | 0.40 | 0.14 |
| 90 | 0.34 | 0.11 |
| 100 | 0.29 | 0.09 |
| 110 | 0.25 | 0.07 |
| 120 | 0.22 | 0.06 |

### Blanket Processing By Leaching of Mass 233 and Contaminants from Thorium Oxide

An ideal blanket processing scheme would consist of leaching either protactinium or $U^{233}$ together with fission and corrosion products from the thorium oxide. The thorium oxide could then be returned directly to the reactor. Limited success has been obtained in leaching $U^{233}$ from thorium oxide by reacting the oxide with 8 M $H_2SO_4$, to convert the uranium to soluble sulfate which is then removed by water washing the solids. The procedure is not practical, however, since 10 liters of 8 M $H_2SO_4$ leach is required per kilogram of $ThO_2$, and the sulfate contamination introduced into the thorium oxide is eliminated only with great difficulty.

### Thermal Breeder Reactor Chemical Processing Flowsheet

The principles which have been outlined may be incorporated into a flowsheet (Figure 2) for chemical processing of the fuel and blanket of a three-reactor power station. It is assumed, for the thermal breeder reactor under consideration, that core and blanket material from three 450-Mw. reactors would be processed in common chemical plant facilities, beginning with the $D_2O$ recovery step, in equipment having a capacity of 200 kg. of thorium/day.

The core will be processed daily through hydroclones for solids removal and on a 190-day cycle through a solvent extraction (Thorex) plant by withdrawing 120 liters daily from the underflow receiver. This volume will contain 149 g. of $U^{233}$ and 10,300 curies of soluble and insoluble fission product poisons. After heavy water recovery by evaporation to 1 M $UO_2SO_4$, the underflow receiver contents will be stored 50 days for decay of short-lived radioactivity before being blended with blanket material. The blanket will be processed on a 320-day cycle through the Thorex plant in order to maintain 3% poison. Sixty-seven kilograms of thorium, together with 338 g. of $U^{233}$ and 67 g. of $Pa^{233}$, will be withdrawn daily in 67 liters of heavy water. This will be blended with the concentrated underflow receiver contents, which have previously decayed for 50 days, and sent to the heavy water recovery step.

#### $D_2O$ RECOVERY

The thorium oxide slurry from the blanket will be combined with 50-day-decayed underflow receiver contents from the core and added to the tray dryer where heavy water will be removed by heating to 300° C. Heavy water losses in the uranyl sulfate and thorium oxide will be less than 0.5 and 0.2 wt. %, respectively.

#### $ThO_2$ DISSOLUTION

The solids, consisting of thorium oxide and the sulfates and oxides of fission products, corrosion products, and uranium, will be slurried out of the evaporator with light water and sent to the dissolver, where the thorium oxide will be readily dissolved in nitric acid containing fluoride ion as catalyst. Dissolution rates increase with increasing excess of

nitric acid, and decrease with increasing temperature of calcination used in preparing the $ThO_2$ originally.

### DECAY

Decay of core and blanket material prior to solvent extraction is desirable for three reasons:

**(1) It permits less thick shielding in the chemical plant, since the controlling element, 40-hr. $La^{140}$, the daughter of 12.4-day $Ba^{140}$, has decayed appreciably.**

**(2) Radiation damage to the tributyl phosphate solvent is decreased.**

**(3) The thorium oxide is more easily prepared with decayed thorium which contains a lower $Th^{234}$ and fission product background.**

Although the solvent extraction plant processing is simplified by handling long-decayed material, inventory charges which accrue on uranium and thorium during decay dictate that the shortest possible decay periods be employed. It now appears that radiation damage to tributyl phosphate and its diluent will determine the minimum decay time. Table 5 summarizes, as a function of decay time, the activity levels expected in the underflow receiver contents and thorium oxide slurry, and the solvent exposure corresponding to each decay time.

Exposure of tributyl phosphate to radiation results in its degradation to mono- and dibutyl phosphate, while the diluent forms organic peroxides (*7*). Exposure of tributyl phosphate diluted with naphtha to an irradiation of 1 watt-hr./liter results in a twofold decrease in the separation of thorium and uranium from fission products in the solvent extraction step. Increasing the exposure to 6 watt-hr./liter of solvent does not result in a further decrease in decontamination. However, a dose of 6 watt-hr./liter produces sufficient mono- and dibutyl phosphates to result in serious emulsion formation in the solvent extraction processing.

Tributyl phosphate extraction processes have been successfully demonstrated at exposure levels of 0.5 watt-hr./liter of solvent. This study is therefore based on that dose. Decay times of 110 days for the underflow receiver contents and of 60 days for blanket material are therefore required. It is, however, likely that a core and blanket decay time as short as 5 days and entailing a solvent exposure of 3.4 watt-hr./liter would be feasible, although it remains to be experimentally verified.

### THOREX PROCESSING (*8*)

After decay, the nitric acid solution of the fuel and blanket will be sent to the feed adjustment step where the solvent extraction (Thorex) process feed will be prepared (Figure 3). In the Thorex process solvent extraction column, uranium and thorium are co-extracted away from fission products and protactinium with tributyl phosphate. In a second partitioning tower, thorium is preferentially stripped from the solvent into nitric acid solution. From thorium nitrate product thorium oxalate is precipitated and is then calcined for refabrication of blanket material. The tributyl phosphate leaving the thorium partitioning tower passes to a third tower where uranium is stripped from the solvent with nitric acid. Uranium-233 is sorbed from the resulting solution by a cation exchange resin and subsequently eluted with sulfuric acid to yield a uranyl sulfate solution which may be returned to the reactor core as fuel.

Thorex process operability on a pilot plant scale has been demonstrated. The Thorex pilot plant is housed in concrete-shielded cells (Figure 4) and is controlled from a central instrument panel (Figure 5). All indicating, recording, and controlling instruments are located on this panel as are the switches for operating pumps, spargers, and agitators in the cell and make-up areas.

A heavily shielded sampler gallery is required in the Thorex pilot plant for obtaining samples of highly radioactive solutions (*9*). Each sampler blister (Figure 6) shields and contains 10 sampling points. Sampling bottles are loaded into one of three carts attached to a shielded conveyor chain and each cart is automatically positioned at its correct blister (Figure 7), reducing the probability of incorrect sampling. The carts are returned to the loading station in the same manner and the sample bottles are secured to shielded carriers for delivery to the analytical laboratory.

### $Pa^{233}$ HANDLING

If 60 days' decay for blanket material is employed prior to solvent extraction, approximately 4% of the mass 233 will be present as $Pa^{233}$. The protactinium will remain with fission products in the waste from the first solvent extraction tower. This waste will be evaporated and stored to permit decay of protactinium to $U^{233}$. The resulting $U^{233}$ will be recovered by solvent extraction with tributyl phosphate.

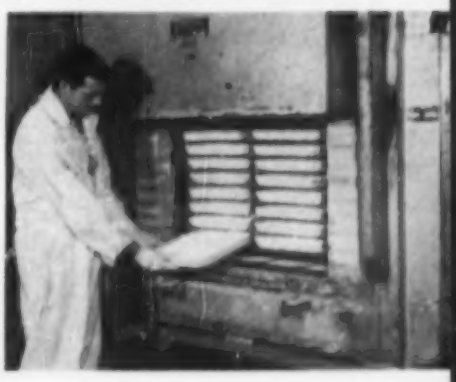
### $ThO_2$ BLANKET REFABRICATION (*10, 11*)

Thorium oxide suitable for blanket use has been prepared on a pilot plant scale. Thorium oxalate is precipitated by the addition of excess oxalic acid to a solution of thorium nitrate at 40° C. (Figure 8). The resulting slurry is

Fig. 8. Precipitator.

Fig. 9. Vacuum filter.

Fig. 10. 60-kw. calcination furnace.



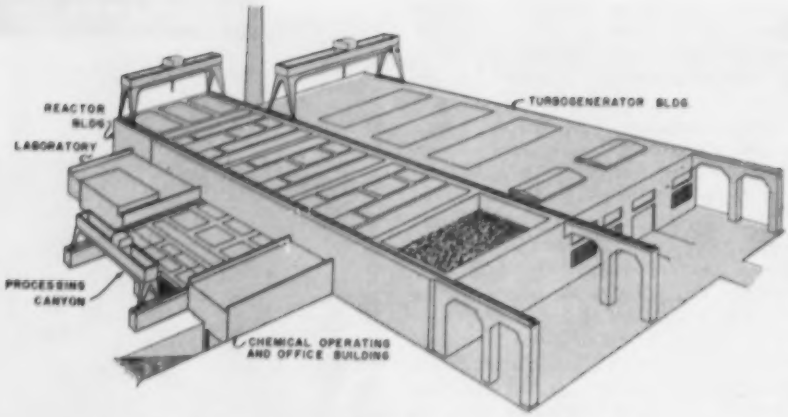



Fig. 12. Two-region reactor station with proposed chemical plant.

passed to a batch vacuum filter (Figure 9) which employs a cotton duck filter cloth, and the mother liquor is filtered off. The thorium oxalate cake is washed three times with hot water, removed from the filter, and placed in a Vitreosil calcination tray. The tray is loaded in a 60-kw. calcination furnace (Figure 10) which has a capacity of 160 lb. of thorium oxide. The furnace heat is gradually increased until final firing temperature is reached.

### $U^{233}O_2SO_4$ REFABRICATION

A cation exchange process is used in the Thorex pilot plant (Figure 11) for $U^{233}$ isolation. It employs two columns filled with Dowex-50 ion exchange resin, a waste catch tank, and a uranium product catch tank. The uranyl nitrate product from solvent extraction flows down through the small column where residual thorium is sorbed, and then passes down through the large column where the uranium is sorbed. $U^{233}O_2SO_4$ fuel will be prepared by eluting the large column with sulfuric acid.

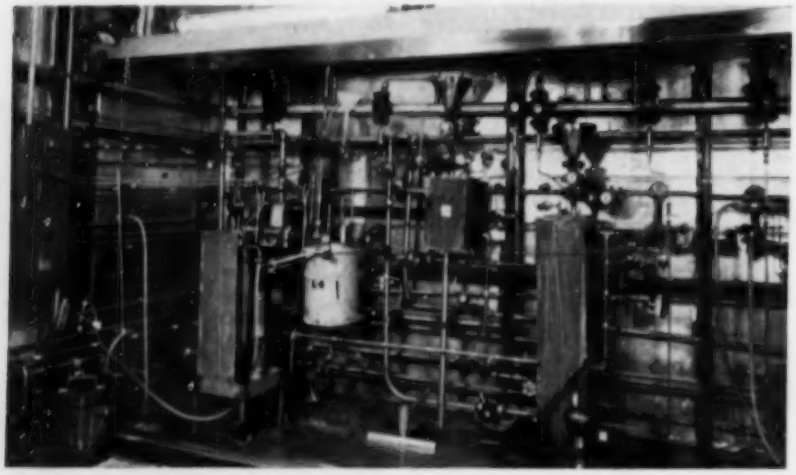
### Thermal Breeder Reactor Chemical Plant Conceptual Design

The flowsheet described above was used as a basis for preparing a conceptual design of a three-reactor-station chemical plant. The arrangement of process cells, analytical laboratory, and operating building is shown in Figure 12. This plant is designed to process fuel from a power station in which three large reactor cells are arranged in line. The three hydroclone cells are buttressed against the wall of the reactor building, and the remainder of the process canyon is an extension of the hydroclone cells, perpendicular to the reactor building.

Immediately adjacent to the hydroclone cells are three cells, one each for heavy water recovery, decay storage, and blanket make-up. These cells, together with the hydroclones, constitute that part of the chemical processing system involving heavy water solution and slurry handling, and are separated from the Thorex process canyon which is designed for underwater maintenance.

The Thorex canyon is divided into two main areas for very and slightly radioactive equipment. The first cell contains dissolution, feed adjustment, acid recovery, and Thorex extraction column equipment. The slightly radioactive area contains the thorium partitioning column, the uranium strip column, and the solvent recovery column. Both areas are operated dry and would be flooded for underwater maintenance.

Fig. 11. Cation exchange, $U^{233}$ isolation process. Uranium product catch tank on left; waste catch tank in center; ion exchange resin columns on right.



### Literature Cited

1. Briggs, R. B., and J. A. Swartout, "Aqueous Homogeneous Power Reactors," *Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Geneva, 1955*, III, Sess. 12A, United Nations, New York (1956).
2. Beall, S. E., and J. A. Swartout, "The Homogeneous Reactor Test," *Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Geneva, 1955*, III, Sess. 13A, United Nations, New York (1956).
3. McNees, R. A., "Chemical Behavior of Some Fission and Corrosion Products in Aqueous Uranyl Sulfate at High Temperatures," meeting, *American Nuclear Society*, Chicago, Illinois (June, 1956).
4. Nurmi, E. O., *et al.*, "Hydraulic Cyclone Study for Liquid-Solid Separation," meeting, *American Nuclear Society*, Chicago, Illinois (June, 1956).
5. Ferguson, D. E., "The Processing of Aqueous Homogeneous Reactor Fuel," *Process Chemistry*, 1, p. 249, Pergamon Press Ltd. (1956).
6. Arnold, E. D., and A. T. Gresky, "Relative Biological Hazards Associated with Nuclear Reactors," meeting, *American Nuclear Society*, Penn. State College (June, 1955).
7. Cathers, G. I., "Radiation Damage to Radiochemical Processing Reagents," *Process Chemistry*, 1, p. 68, Pergamon Press Ltd. (1956).
8. Gresky, A. T., "The Separation of $U^{233}$ and Thorium from Fission Products by Solvent Extraction," *Process Chemistry*, 1, p. 212, Pergamon Press Ltd. (1956).
9. Duggan, H. G., and J. W. Landry, "Remote Liquid Sampling: A Completely Automatic Air-Lift System," *Nucleonics*, 12 (11), 67-69 (1954).
10. Allred, V. D., S. R. Buxton, and J. P. McBride, "Characteristic Properties of Thorium Oxide Particles," meeting, *Amer. Chemical Society*, Dallas, Texas (1956).
11. Allred, V. D., and J. P. McBride, "Properties of Hydrothermally Prepared Thorium Oxide," meeting, *American Nuclear Society*, Chicago, Illinois (June, 1956).

# COUNTERCURRENT ION EXCHANGE

During the past three years the continuous ion exchange program at Oak Ridge National Laboratory has been broadened to include development, pilot planting, and introduction into the field. At present the last-mentioned aspect is well under way. Thus, in addition to describing the fruits of research, this paper also reports on a practical application in the field of one of the columns designed for processing low-grade Western uranium ores. This constitutes a milestone in the program since the ore column is the first of its kind to be applied in the work of the A. E. C. and outside of the Commission's program it represents a first application to a job other than water softening. Included is a report on some resin attrition tests made during the normal course of the program.

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Fig. 6. 12-in. semicontinuous ion exchange column.

In the business of the Atomic Energy Commission, it is frequently necessary to employ ion exchange. During World War II fixed beds were used and this work has already been reported (*10*).

Unfortunately, for larger than laboratory scale, a fixed bed has obvious disadvantages. Consequently in the processing, for example, of low-grade Western uranium ores, a stagewise continuous operation has been employed for some years by subcontractors of the A.E.C. The operation has been successful. However, the operating efficiency, manpower requirements, and the chemical efficiencies are open to question.

Shortly after the War a program of continuous ion exchange development was undertaken at the Oak Ridge National Laboratory in recognition of the foregoing difficulties and the desirability of a strictly continuous operation. At that time such commercial units were not available for the problems at hand (*3*).

To expedite the program, certain unclassified portions were (*11*), and still are (*9*), contracted on the outside and the rest of the program was continued at O.R.N.L. The program led to the development of a continuous ion exchange column (*6, 4*) in 1950, a semicontinuous column similar to Stanton's (*12*) and McIlhenny (*7*) in 1952, and a semicontinuous column of considerably different design (*2*) in 1953.

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Additional material, including a Graphical Analysis, is on file (Document 4975) with A.D.I. Auxiliary Publications Project, Library of Congress, Washington, D. C. Material obtainable by remitting $1.25 for photoprints or $1.25 for microfilm.

Only the first and last of the columns will be described further since they have practical application for A.E.C.; also the second column has been described in detail elsewhere (*11*).

### Continuous Ion Exchange Column

A schematic diagram of the continuous countercurrent ion exchange column is shown in Figure 1.

The column is equipped with a jet at the bottom and a number of inlets and outlets. Other than for the jet connection, each inlet and outlet is equipped with a screen which is fine enough to filter the resin from the liquid as the latter drains or is withdrawn from the column.

The column itself is filled with an ion exchange resin and liquid. Throughout the operation, the bed is maintained in the dense bed form. The top level of the bed is at the inlet from the ram pump at the top of the column and the liquid extends above the top level of the bed by about a half inch.

During operation the resin moves downward always as a dense bed. Movement is due to the jet action at the bottom of the column. The resin is returned to the top of the bed as indicated in Figure 1. Appropriate streams are fed as indicated on the left of the figure and withdrawn as indicated on the right.

Other attempts to operate a column of this kind (*8, 11*) have failed to recognize that the column must be kept in hydraulic balance (*5, 6*) to prevent (a) fluidization, and (b) cocurrent flow of liquid streams and resin.

The upflow of liquid through the resin would tend, at the higher flow rates, to fluidize the resin and limit the range of dense bed operation. The hydraulic ram (*6*) is provided in order to remove this limitation. The liquid is pumped down through the section of the column labeled

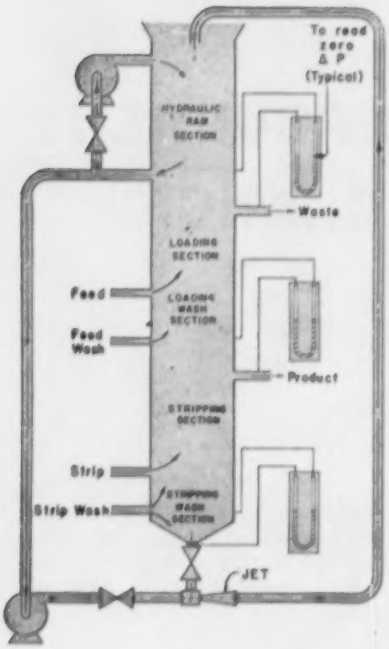



Fig. 1. Continuous ion exchange column with hydraulic ram.

hydraulic ram section. The frictional drag of liquid on the resin forces it down like a piston. This downward force in the resin phase is transmitted to the loading section, stripping section, and washing sections; thus fluidization effects are counteracted and prevented.

The valves at the bottom of the column are provided for zeroing the lower manometer and regulating the resin flow rate. The feed wash and product streams are balanced to zero the intermediate level manometer. The ram water withdrawal and the waste streams are balanced to zero the top manometer. When all three manometers are zeroed, the entire contactor is in hydraulic balance, that is, no fluid circulation among unrelated sections of the contactor and no fluidization. Such a column has been operated at several fold the fluidizing velocity with no signs of fluidization.

**The continuous column enjoys the advantages of (a) remaining on stream 100% of the time with no lost time in moving the resin, (b) of having the H.T.U. or H.E.T.S. less since cocurrent flow and partial fluidization are never permitted in the loading and stripping sections, and (c) operating at considerably lower pressures since there is no need to move relatively large amounts of resin in short times—instead the resin moves constantly and smoothly at modest flow rates.**

### Semicontinuous Ion Exchange Column

A series of three schematic diagrams of the semicontinuous, countercurrent ion exchange column is shown in Figure 2.

**The vertical portion on the left of what appears to be a loop is the ion exchange column itself. The right hand vertical portion simply provides a path for returning resin as shown in the third schematic in the figure. In general the column is equipped with screens and supplied with streams in much the same way as the continuous column.**

**The distinguishing feature of the semicontinuous column is that its valves are operated by a sequential timer and the resin return leg is equipped with a pump which is also tied to the timer along with other stream pumps (not shown in Figure 2).**

A sequence of three operations is repeated ad infinitum as determined by the sequential timer. The first operation is illustrated in the first diagram of Figure 2. The pump in the diagram is inoperative. The valves are set as indicated and the streams flow down through the column, which is divided by the mid-height valve into two stationary dense beds, the top one being a loading section and the bottom being a stripping section. This arrangement of loading section over the strip section is preferable in slurry operations because adherent mud can be washed from resin in the return leg if the latter is equipped for doing so.

After several minutes the timer shuts the column down and changes the valves as shown in diagram 2 of Figure 2. The timer turns the pump on to pump liquid in the direction of the arrows. The high pressure drop across the resin bed causes part of the water to flow or "slip" cocurrently through the bed. This action partially fluidizes the bed, but before it can become completely fluidized, the frictional drag of the "slip water" drags the bed along and upward into the right-hand leg (see second diagram).

After an appropriate amount of resin has been moved (3-5 sec.) the timer shifts the valves as shown in the third diagram. The streams are turned on and the pump piston returns to its original position, driving all resin in the return leg to the bottom of the leg. The timer then shuts the pump off and the operation becomes that illustrated in the first diagram of Figure 2.

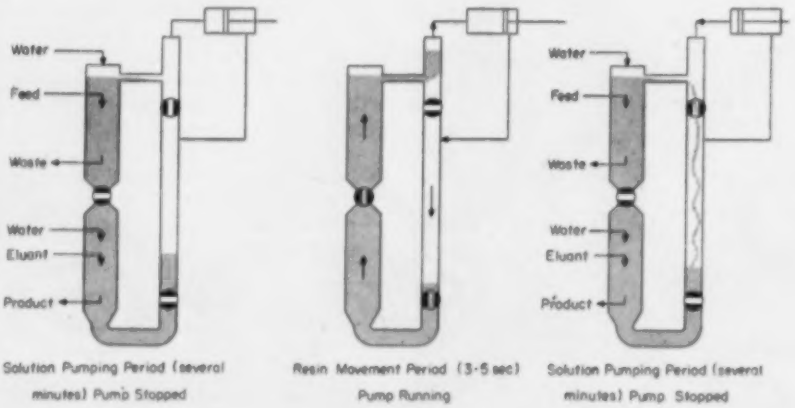
Other details of the semicontinuous column have been published (*2*). What is important is that the semicontinuous column represents another way of carrying on ion exchange which has been useful in the program. It enjoys the advantage that by virtue of liquid downflow, prevention of fluidization is automatic. This comes, of course, at the expense of the additional sequential timer and valving arrangement.

### Column Selection, Expanded Program

At the time the continuous ion exchange program was expanded to include pilot planting and field testing, it was necessary to choose a field application and column such that the work could be slanted accordingly. For this purpose ore processing appeared to be most urgent. The semicontinuous column was selected on the basis that some of the early experiments on uranium had been run on this type column.

Expansion of the program involved three phases. The first phase involved pilot planting a semicontinuous 6-in. col-

Fig. 2. Schematic diagram of semicontinuous ion exchange column, showing mechanism of countercurrent solid-liquid flow.



unit operations in nuclear engineering

# ION EXCHANGE

umn on a synthetic uranium feed solution which contained no mud. The second involved scale-up to a 12-in. column based on the 6-in. column experience. The third phase involved checking the 12-in. column hydraulically before shipping to the field, checking resin attrition, and then testing in the slurry operation in the field.

### THE 6-IN. SEMICONTINUOUS COLUMN

The 6-in. column is shown in Figures 3 and 4 and consists of a loop exactly as diagrammed in Figure 2. The exchange column stands vertically in the center of Figure 3 and at the left of Figure 4. The return leg stands vertically in the middle of the right half of Figure 3 and in the middle of Figure 4. The two are connected at the bottom in Figure 3 and toward the top in Figure 4. The piping in the background of Figures 3 and 4, particularly the horizontal piping is, unfortunately, the standard pilot plant supply lines for steam, air, water; they have nothing to do specifically with the column.

The instruments and sequential timing mechanism can be seen in the two relay racks positioned on the first floor at the left of Figure 3.

Figure 3 departs from Figure 2 in that the column shows operation without the valve between the loading and stripping sections; the column being balanced hydraulically, no valve was necessary. During actual tests a 4-in. plug valve was used.

The feed and draw-off points in the column can be identified in Figures 3 and 4 by the flanges at these points in the column. The Roper gear pump used to pulse the resin is shown at the lower right of Figure 4. Various pumps were used from time to time in stream service and these were located down behind the control and instrument relay racks.

The loading section was 4-ft. high, 6-in. diam. The water-wash section at the top of the loading section was 4-ft. high, 4-in. diam. The stripping section was also 4-ft. high, 4-in. diam. Its water-wash section was 1-ft. high, 4-in. I.D.

### RESULTS OF TESTS

**A 46-hr. test was made to determine the number of resin cycles necessary to approach a steady-state condition and to obtain steady-state chemical data. Owing to the limited supply of mill-pulp slurry, a synthetic feed consisting of 0.57 g. uranium and 17.0 g. sulfate as magnesium sulfate/l. was substituted. Table 2 gives run details. Outlet samples were analyzed until they were constant. About three resin cycles were needed. The feed rate was 1.3 gal./min.; this is approximately 390 gal./(hr.)/(sq.ft.) of loading section cross-section.**

After the contactor was at "steady-state," samples of all the streams were analyzed for key components. These results are shown in Table 1.

### Equilibrium Data

The separation factors $\alpha$ must be determined if one is to analyze the column results successfully. For this reason, 100 cc. of settled Permutit SK (10 to 20 mesh) resin bed were loaded (*1*) with uranium and sulfate ion by treating it in a column with synthetic uranium feed liquor. After loading, the resin was treated batchwise with 100 cc. of strip solution containing 0.9 M $NH_4NO_3$ and 0.1 M $HNO_3$. The batch was shaken to equilibrium and then filtered and the liquid analyzed for uranium sulfate and nitrate. The process was repeated seven successive times with the same resin but with new 100-cc. batches of strip liquor each time.

Experimental results were analyzed (*5*) on the assumption that the anions in the resin phase and solution phase were

$SO_4^{2-}$, $NO_3^{1-}$ and $UO_2(SO_4)_3^{4-}$

The separation factor equation for the reaction

$$2\,RSO_4 + UO_2(SO_4)_3^{4-} = RUO_2(SO_4)_3 + 2\,SO_4^{2-} \qquad (1)$$

was found to be

$$134.8 = \frac{C_o}{C_r}\,\frac{y^*}{x}\left[\frac{1-x}{1-y^*}\right]^2$$

where

$C_o$ = total equivalents of exchangeable ion in solution, equivalents / cu.ft.

$C_o$ = total equivalents of exchangeable ion in resin, equivalents / cu.ft. of resin particle (2)

For the reaction

$$RUO_2(SO_4)_3 + 4\,NO_3^- = 4\,RNO_3 + UO_2(SO_4)_3^{4-} \qquad (3)$$

it was found that

$$9.69 = \left(\frac{C_o}{C_r}\right)^3\,\frac{y^*}{x}\left[\frac{1-x}{1-y^*}\right]^4 \qquad (4)$$

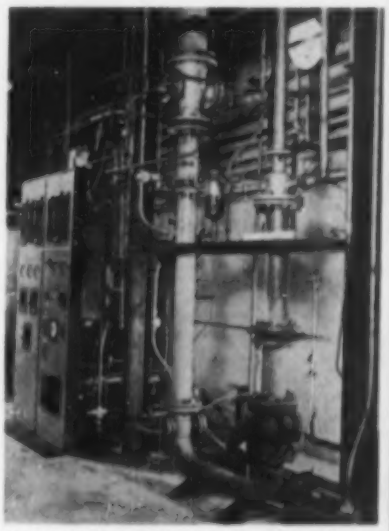
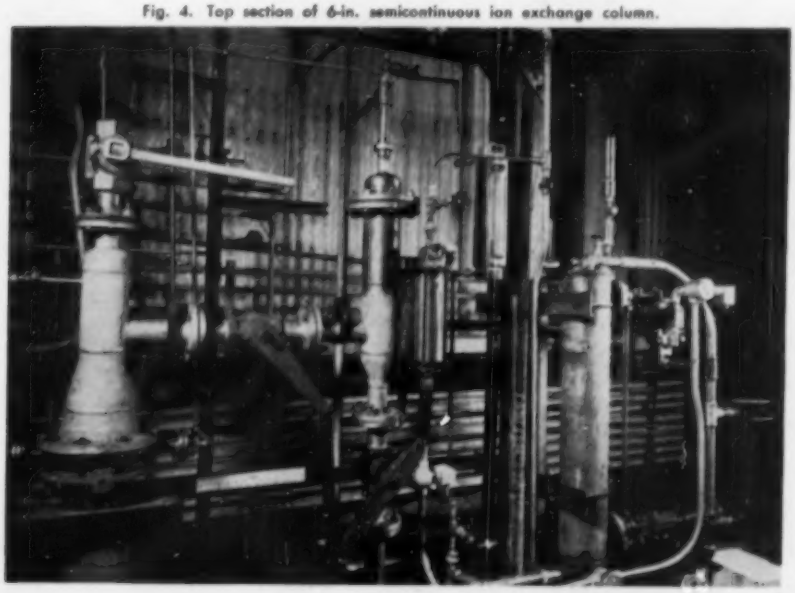


Fig. 3. Bottom section of 6-in. semicontinuous ion exchange column.

Fig. 4. Top section of 6-in. semicontinuous ion exchange column.



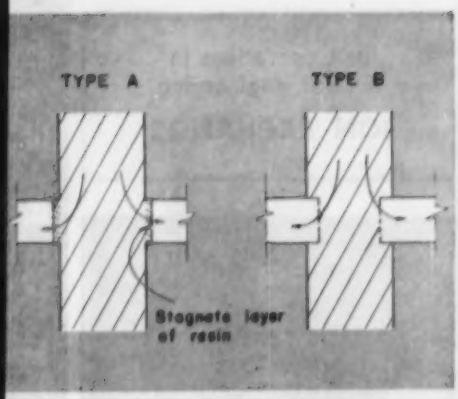



Fig. 9. Liquid takeoffs for semicontinuous ion exchange column.

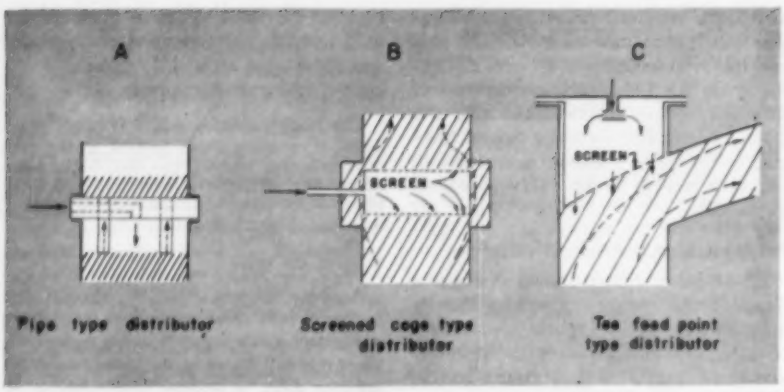



Fig. 10. Liquid distributors for semicontinuous ion exchange column.

**Table 1.—Operating Conditions for Run 6-14**

Flow Conditions:

| Stream | Rate gal./min. | Concentration |
|---|---|---|
| Feed | 1.3 | 0.57 g./l. U<br>17.0 g./l. $SO_4^{-2}$ |
| Feed wash | .31 | Water |
| Strip | .042 | 1.0 M $NH_4NO_3$<br>0.1 M $HNO_3$ |
| Strip wash | .008 | Water |
| Product | .045 | 13.6 g./l. U |
| Resin at top of loading section | .015 | 41.22 g./l. U |

Results:

| | |
|---|---|
| Material balance | 92% |
| Flow balance | 105% |
| Uranium recovery | 85% |
| Resin cycles | 3.5 |
| Slip water ratio | 1.7 |

$$\text{Slip water ratio} = \frac{\text{pulse water pumped volume}}{\text{resin bed volume moved}}$$

**Table 2.—Terminal Conditions for Run (6-14)[a]**

| Loading Section | | Stripping Section | |
|---|---|---|---|
| X | Y | X | Y |
| .0271 | .4508 | .3498 | .4508 |
| .0023 | .0308 | 0 | .0308 |

[a] Where x and y are equivalent fractions.

**Table 3.—Results from Stepping-off Stages on Equilibrium, Operating Line Diagram**

6-in. contactor run (6-14)

| Section | Length (ft.) | N.E.T.S. | H.E.T.S. (ft.) |
|---|---|---|---|
| Loading | 4 | 2.2 | 1.8 |
| Stripping | 4 | 1.5 | 2.7 |

**Table 4.—Length Needed for 12-in. Contactor for 99.5% Recovery**

| Section | N.T.S. | H.E.T.S. (ft.) | Required length (ft.) |
|---|---|---|---|
| Loading | 3 | 1.8 | 5.4 |
| Stripping | 2.0 | 2.7 | 5.4 |

**Table 5.—Test Conditions for 12-in. Contactor**

| Concentration | Design (g./l.) | Actual (g./l.) |
|---|---|---|
| Feed—uranium | 0.57 | 0.35 |
| $SO_4^=$ | 17.0 | 18.70 |
| Strip—$NH_4NO_3$ | 80.0 | 80.0 |
| $HNO_3$ | 6.3 | ..... |
| $SO_4^=$ | ..... | 19.0 |
| Waste—uranium | .003 | .003 |
| Product—uranium | 13.6 | 4.3 |
| Resin—uranium (Top of loading section) | 41.22 | 33.6 |
| **Rates** | gal./(hr.)(sq.ft.) | gal./(hr.)(sq.ft.) |
| Feed | 390 | 383 |
| Feed wash | 95 | 38 |
| Waste | 485 | 421 |
| Strip | 16.6 | 63.6 |
| Strip wash | 5.5 | 58.4 |
| Product | 22.1 | 122.0 |
| Resin rate (Top of loading section) | 4.6 | 3.8 |

**Table 6.—Test Conditions and Results of 12-in. Contactor Slurry Test**

| Flow | Rate (gal./min.) |
|---|---|
| Feed | 5.00 |
| Feed wash | 0.50 |
| Strip | 0.37 |
| Strip wash | 0.34 |
| Resin | 0.05 |
| Slip-water ratio | 4.0 |
| Recovery | 99.25% |
| Feed concentration | 0.4 g./l. as $U_3O_8$ |
| Resin loading (top of loading section) | 40.0 g./l. as $U_3O_8$ |
| Loss | .003 g./l. as $U_3O_8$ |

In each case, the $x$ and $y$ values are the appropriate equivalent fractions for the liquid and resin phases.

**Scale-up Procedure**

The separation factors $\alpha$ from the batch equilibrium data were used to calculate the equilibrium curves of the two sections shown in Figure 5.

Concentrations of the steady-state samples for run (6-14) were converted to equivalent fractions as shown in Table 2. These equivalent fraction values determine the coordinates of the two operating lines that were used on the two-curve diagram (*5, 12*) (see Figures 5, and Table 2).

Stages were stepped off between the equilibrium curves and the operating lines by the conventional method (*5, 12*). The number of transfer stages (N.T.S.) for the loading section were 2.2 and 1.5 for the stripping section. Each of the sections was 4 ft. long (see Table 3).

On the assumption of the same feeding conditions of run (6-14) and still with the use of the 6-in. contactor data, the (N.T.S.) required were three in the loading section and 2.0 in the stripping section to have a uranium recovery of 99.50%; this presupposes all of the loss to be in the loading section. The new two-curve diagram for this case has been omitted because it was a minor modification of Figure 5, the other two-curve diagram, in that the loading-section operating line had been extended until the loss was 0.5%. The product concentration was assumed to remain constant, due to changing the stripping conditions slightly from run (6-14). Therefore, the slope of the stripping operating line was changed accordingly.

The final job was to design a semicontinuous, 12-in. column which operated essentially the same as the 6-in. design but with 99.50% recovery. Also, the diameter had to be doubled to increase the production capacity to the desired level. To accomplish this, it was

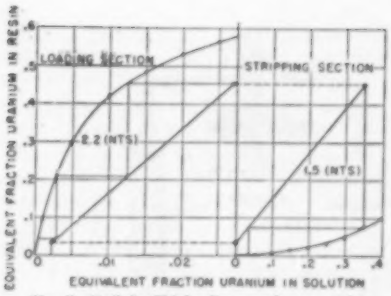



Fig. 5. McCabe-Thiele diagram for run 6-14.

assumed that doubling the diameter of the contactor only changes the production capacity, and not the (N.T.S.) for the same operating conditions. Thus, the (N.T.S.) in the various sections of the 12-in. contactor are the same as in the 6-in. contactor. Design results are shown in Tables 4 and 5.

In view of the urgency of the work, the size of the loading and stripping sections of the 12-in. contactor was actually estimated at 7 ft. each prior to the completion and analysis of the 6-in. column data. While the 12-in. contactor was being constructed, the foregoing 6-in. contactor work was completed and analyzed. In spite of the excess column length, the actual uranium recovery averaged 99%, owing to lack of steady-state column operation (see Table 5).

#### Refinement of the 12-in. Column

The loading and stripping sections of the contactor were placed beside instead of on top of each other as was the case for the 6-in. contactor design. The advantage of this arrangement was that the total contactor height was decreased (see Figures 6 and 7). The increased length of the resin flow path, however, increased the slip water ratio somewhat.

The liquid distributors and liquid take-off screens shown in Figures 9 and 10 were placed in the resin flow path. If the screens were not so placed, a stagnant layer of resin in front of the screens increased the plugging tendency of the screens.

#### Preparation of Mill Pulp Slurry

The mill pulp slurry (see Figure 8) was prepared by dry crushing, grinding, and wet ball-milling before the sulfuric acid leaching. After leaching, the sand was removed from the slurry with the use of a drag classifier and of liquid cyclones. If the classification circuit was operated at an optimum rate, the resulting slurry should contain less than 1% of the solids which are larger than 325-mesh. The density should be 1.03 to 1.08 g./cc.

#### SLURRY TEST OF 12-IN. CONTACTOR

A slurry test was made with the assistance of the National Lead Company, Inc. The feed slurry was prepared from White Canyon, a low-grade Colorado ore. It was characterized as follows:

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Concentration ..... 0.4 g./l. as $U_3O_8$
Density ..... 1.05 g./cc.
Solids ..... passed a 200-mesh screen

The actual operating conditions of the 12-in. column are shown in Tables 5 and 6. Pilot test time on the contac-

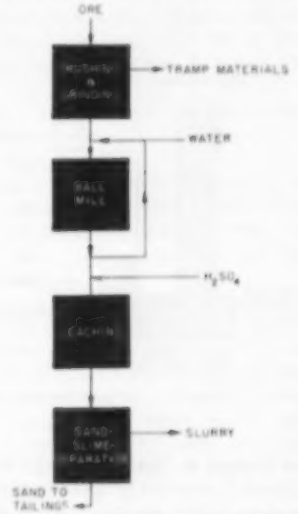
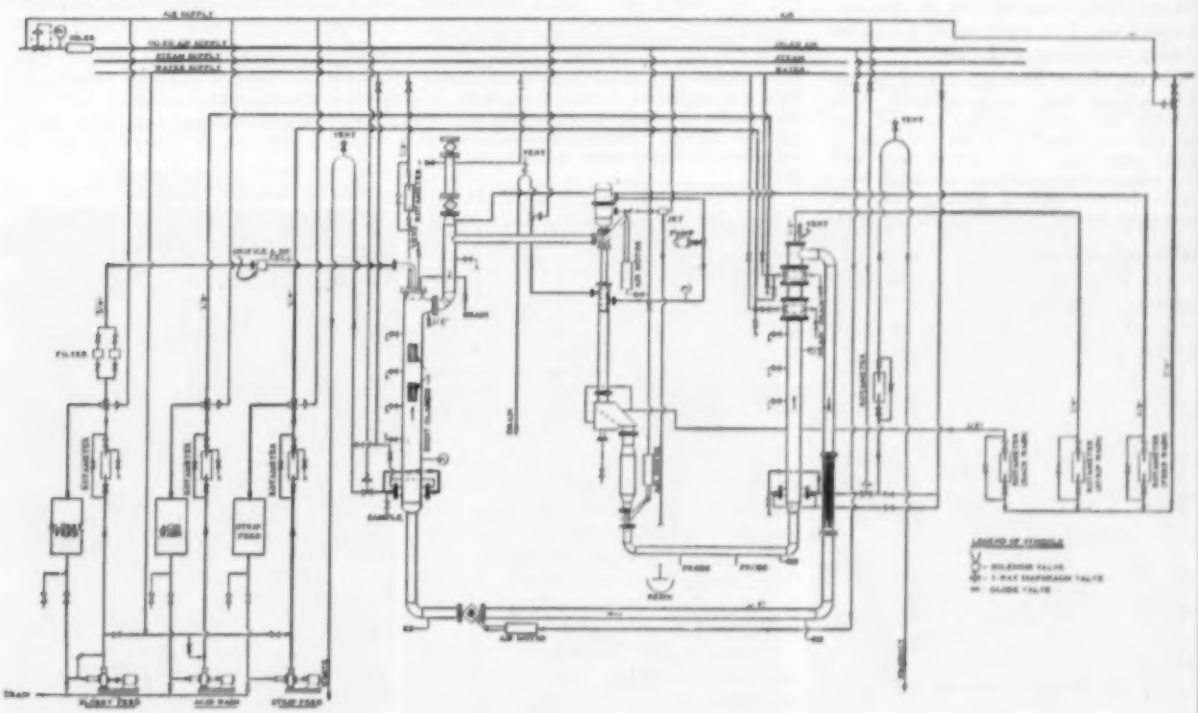



Fig. 8. Flow sheet for mill pulp slurry preparation.

Fig. 7. Process piping flow sheet.



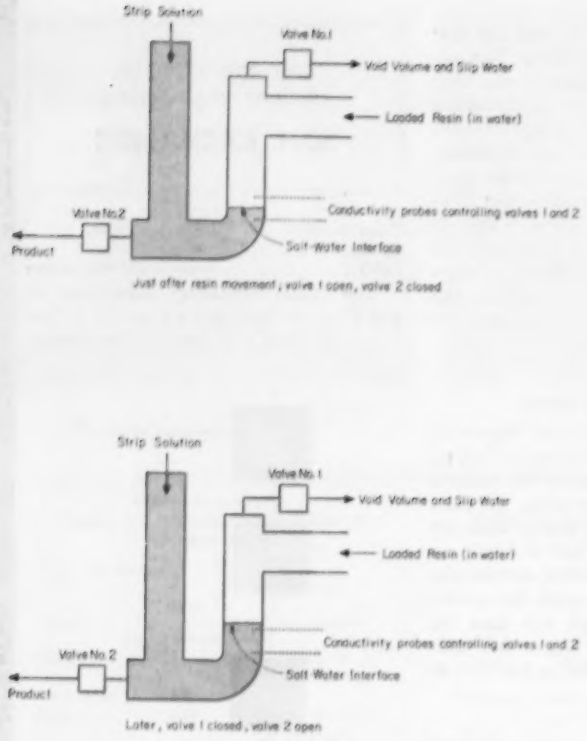



Fig. 11. Conductivity-type water eliminator.

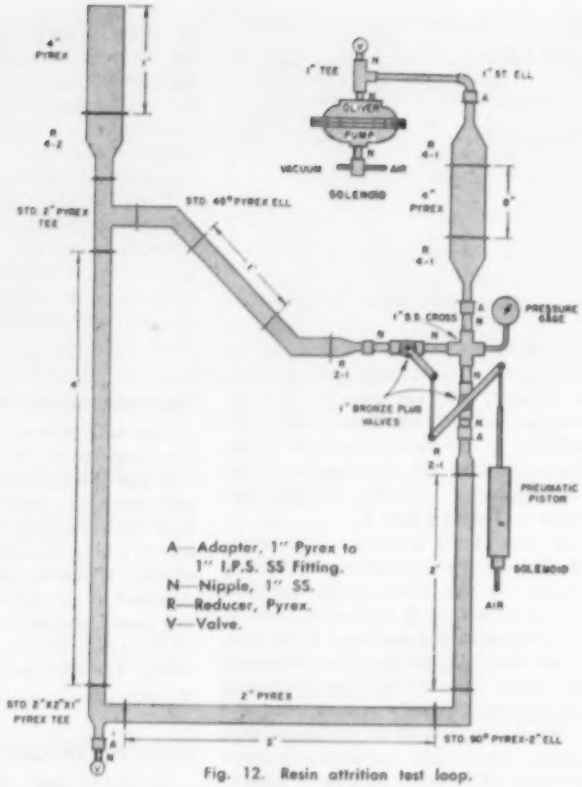



Fig. 12. Resin attrition test loop.

tor was limited at National Lead Company, hence it was not possible to reach steady state in the operation as is obvious from Table 5 in particular. The product solution, for example, rose in uranium concentration all through the run and was still increasing at the time of shutdown. The waste losses were also steadily decreasing with time.

The slip water ratio was higher in the 12-in. column that was anticipated. This probably had some bearing on the fact that the strip rate had to be increased in actual operation. The actual feed and strip compositions differed somewhat from design because actual product solutions were used during the course of the tests.

### Mechanical Components

During the development of the semi-continuous ion exchange contactor, the mechanical components were modified to meet the operating conditions.

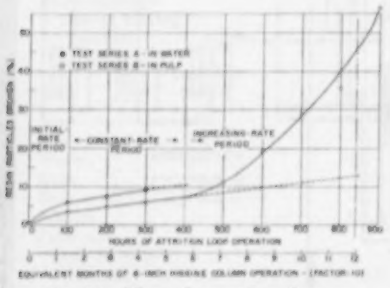



Fig. 13. Effect of operating time on resin attrition.

The resin valves, for example, that isolate the sections from one another were open-area plug valves (approximately 70% of the pipe cross-sectional area). These valves did not appear to cause appreciable resin attrition because the sheer area of the valve on closing was small. The valves were successfully driven by a piston-type air motor.

For operational dependability and safety, it was felt that air-operated solution valves were superior to solenoid-operated types. Two 8-v. solenoid valves were used to control the air supply to a number of air-operated valves. The two solenoid valves were located where water spillage was unlikely.

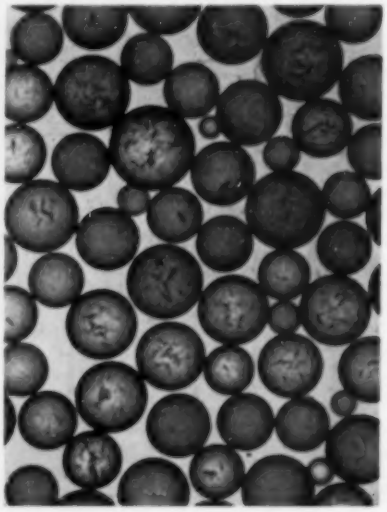
If the slip-water ratio is too great, the product concentration may be decreased due to dilution by slip water. The slip-water eliminator system (Figure 11) was installed between the reservoir section and the stripping section to remove the excess slip water and, therefore, to increase the concentration of the product. The slip-water-eliminator system consisted of two air-operated valves: one on the product take-off line and the other on the slip-water outlet. These are controlled by the conductivity controller.

The slip-water outlet was placed at such a distance from the product take-off that the volume between the two points was greater than the slip-water volume. Two electrical probes were located near the slip-water outlet and were connected to the conductivity controller, as shown in Figure 11.

After the resin has been pulsed, the slip water, which has a low conductivity, covers the probes. When the conductivity controller senses this low conductivity, it opens the slip-water valve and closes the product valve. The incoming stripping solution forces the slip water out of the stripping section through the slip-water valve. When the product, a result of the stripping solution, mainly 1 M $NH_4NO_3$, covers the probes, this highly conductive solution causes the controller to open the product valve and to close the slip-water valve.

The resin movement controller con-

Fig. 14. Initial resin particles before test series B. Permutit SK (10-20 mesh). 8.75X.



sisted of three parts: a timer to measure the liquid flow period; a timer to allow the valves to change from the run position to the resin moving position; and a timer to regulate the length of time the pulse pump runs to move a prescribed amount of resin. Two types of timing system were used: one consisted of a gang of cams equipped with microrelays, and adjustable timers; the other system consisted of three timers that operated at a set sequence.

The feed slurry pump should be a positive displacement pump with little or no pulsing flow. The pump should be able to pump against a 30 lb./sq.in. head. For both contactors, Moyno pumps were used. It appeared that the service life of the pump was endangered if the pump was operated faster than 500 rev./min. The pumps were controlled with Reeves Variable Speed Drives but any other variable-speed system would have been satisfactory.

#### Mechanical Attrition Test Procedure

The attrition loop used in this investigation is shown in Figure 12.

The loop consisted essentially of a circulation system of 2-in. Pyrex pipe, interconnected bronze plug valves, and an Oliver diaphragm pump operating with pressure and vacuum connections. Glass pipe could be used because attrition is primarily due to valves and fittings.

During the studies, it was necessary to operate the loop for prolonged periods. The loop was equipped with automatic timing controls, activating alternately the solenoid valves on the Oliver pump and the pneumatic piston. It was found that the loop could be operated continuously for several days with a minimum of attention.

Samples were taken every 100 hr. of loop operation. The resin was photographed at magnification 25× and the particles were counted to determine the percentage of broken particles. The following equation was used to calculate the per cent broken:

$$\text{Per cent broken} = \frac{A + B/2}{A + B/2 + C} \times 100 \quad (5)$$

Where:

$A$ = broken particles larger than half-spheres

$B$ = broken particles smaller than half-spheres

$C$ = whole resin particles

#### RESULTS OF ATTRITION TESTS

Two series of tests were carried out with the attrition loop: test series A (resin circulated in water) and test series B (resin circulated in mill pulp). Results of these tests are shown graphically in Figure 13.

As may be seen from the figure, the attrition curve may be considered to have three separate sections: an initial-rate period, a constant-rate period, and an increasing-rate period. The initial-rate period is probably the result of the high initial break-up of particles which were cracked or weakened during the manufacture of the resin.†

The constant-rate period probably represents the rate of attrition of structurally sound resin particles containing a small percentage of broken pieces.‡

Figures 14 through 17 are photomicrographs of samples of resin taken from the attrition loop at 0, 300, 600, and 900 hr. of test series B. The pictures show qualitatively the resin attrition as a function of time. For statistically significant data, it was necessary to count broken and unbroken particles on a large number of photographs at each sampling period.

† There was a higher initial break-up rate during test series A than during test series B. The resins for these two tests were from two separate shipments from the manufacturer. It is probable that there was a significant difference in the percentage of structurally sound particles between the two shipments.

‡ The constant rates for the two test series were essentially equal. Obviously there was little effect of the mill pulp present in test series B on the constant-rate attrition.

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#### Literature Cited


1. Higgins, I. R., Personal Communication.
2. Higgins, I. R., and J. T. Roberts, *Chem. Eng. Progr. Symposium Series*, **50**, 87 (1954).
3. Hutcheson, J. M., *Chem. Process Eng.*, **34**, 271-75 (1953).
4. Jury, S. H., O.R.N.L. CF 50-9-80 (1950). *Tech. Inform. Service*, U.S.A.E.C., Oak Ridge, Tennessee.
5. Jury, S. H., O.R.N.L. CF 52-6-164 and Supplement No. 1 (1952); O.R.N.L. CF 55-6-74 (1956) and 55-8-10 (1955). *Tech. Inform. Service*, U.S.A.E.C., Oak Ridge, Tennessee.
6. Jury, S. H., *Nuclear Science Abstracts*, **8**, 173 (1954).
7. McIlhenny, W. T., and V. O. McConnell, U. S. Patent 2,671,714 (March 9, 1954).
8. Nordell, C. H., U. S. Patent 1,608,661 (November 30, 1926); U. S. Patent 1,722,938 (July 30, 1929); U. S. Patent 1,740,199 (December 17, 1929).
9. Peebles, F. N., and R. M. Boarts, University of Tennessee, Union Carbide Nuclear Co. Subcontract No. 783 Under W-7405 eng-26 (1955).
10. Staff, O.R.N.L., *JACS* 69, 2769-2881 (1947).
11. Stanford Research Institute, U.S.A.E.C. COO-41 (rev) (1951), and COO-59 (1952), *Tech. Inform. Service*, U.S.A.E.C., Oak Ridge, Tennessee.
12. Stanton, L. F., M.S. Thesis, University of Washington (1950).


Fig. 15. After 300 hr. attrition loop operation. Test series B. 8.75X.

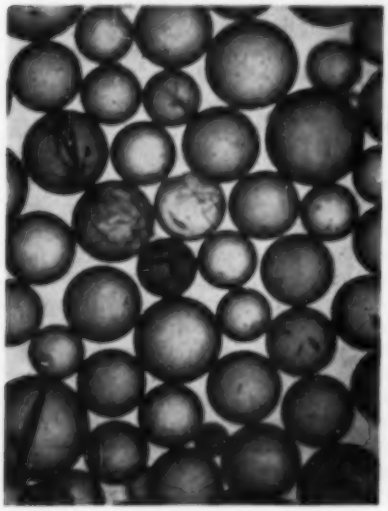

Fig. 16. After 600 hr. attrition loop operation. Test series B. 8.75X.

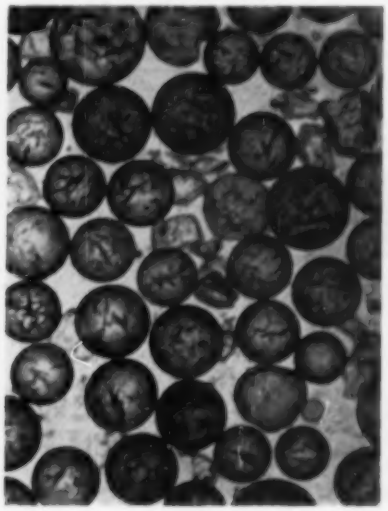

Fig. 17. After 900 hr. attrition loop operation. Test series B. 8.75X.

**In an investigation of the separation of uranium as a magnesium precipitate from refinery waste solutions with a laboratory Dorr thickener, solids were distributed between the underflow and overflow in a 9:1 ratio, and overflows were relatively clear under all but the most dilute feed conditions.**

**A comparison was made between the effectiveness of magnesia and hydrated lime as a neutralizing and precipitating agent. Magnesia showed significant advantages in overflow clarity and underflow density.**

# URANIUM REFINERY WASTE CLARIFICATION

*G. M. Reinhart and D. W. Glass* | The National Lead Company of Ohio, Fernald, Ohio.

All liquid process wastes from a uranium refinery must be collected and treated before they can be discharged from the plant site. The refining process (*1*) contributes nitrates of uranium and other metals, nitric acid, halides, and insoluble ore residues which can be released to a near-by river only in small quantities because of their proven or potential toxicity and the danger of adding appreciably to stream pollution. Most of the volume of the waste liquor is made up of water which must be processed because of its uranium content, even though precautions are taken to minimize such contamination.

The combined waste is usually acidic, but if this is not the case, it can be acidified with nitric acid to provide favorable preneutralization conditions. Uranium in the form of uranyl nitrate is the major constituent of the waste and is precipitated by magnesia as magnesium diuranate:

$$MgO + H_2O \rightarrow Mg(OH)_2$$

$$2\ UO_2(NO_3)_2 + 3\ Mg(OH)_2 \rightarrow MgU_2O_7 + 2\ Mg(NO_3)_2 + 3\ H_2O$$

If neutralization is continued to a $p$H of about 8, a well-flocculated precipitate is formed. Other metals are precipitated at the same time, probably as hydroxides. These solids, as well as those insolubles originally present in the acid waste, must be removed and returned to the refining process.

A common method for the clarification of acidic industrial wastes makes use of pressure-leaf filters to remove traces of solids from the neutralized liquid. The limited cake capacity of this type of filter leads to high operating costs when frequent cleaning is made necessary by volume surges or solids concentration of the incoming waste liquor. The capacity of the system is also very limited under these conditions. A primary stage of solids separation preceding the filters would reduce costs and provide greater surge capacity. To test the feasibility of a continuous tray thickener operating with a characteristically dilute waste feed, a laboratory unit was installed and operated.

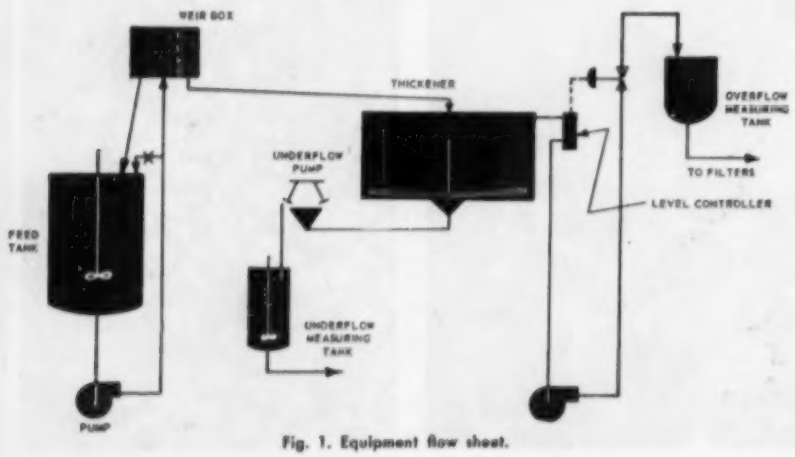


Fig. 1. Equipment flow sheet.

## Equipment

The Dorr-Oliver laboratory thickener used was a flat-bottom tank 5 ft. in diam. and 3 ft. high. A Dorr-Oliver No. 0, Type VM diaphragm pump was used to handle the underflow. Neutralized slurry was circulated between a precipitating tank and a weir box which was 1 ft. wide by 2 ft. long by 2 ft. deep. The box was provided with a 30°, 8-in.-deep notch, and a 3-in. diam. adjustable overflow so that feed rate to the thickener could be varied. The equipment and its arrangement are shown in Figures 1 and 2.

## Experimental Procedure

A 5,000-gal. batch of raw feed was transferred to the preparation tank, acidified with nitric acid if necessary, and neutralized to $p$H $8 \pm 0.5$ by the addition of dry lime or magnesia. The empty thickener was filled while the feed rate was being adjusted to maintain the desired flow as determined by the weir. In later runs, the feed rate was checked by the rate at which the thickener filled after feed adjustment. A 1-hr. period, during which a partial equilibrium was established, was allowed before sampling was begun. Five samples, taken at 15-min. intervals, were taken in each run and composited for analysis. During early runs hourly samples were analyzed and compared to determine the uniformity of the feed and product streams, and thus to establish achievement of steady-state operation.

## Results

Data in Table 1 show that the thickener successfully separated a dilute magnesia-precipitated feed into an underflow of satisfactory density and an overflow having a clarity suitable for feed to the polishing filters.

Uranium losses in the overflow were less than 10% of the feed except for a few runs made with unusually dilute feeds. Insoluble solids were present in a ratio of about 3 : 1 to the uranium. The overflow losses increased as expected, as the volumetric and mass feed rates increased (Figure 3), but at no time did they become high enough to prevent

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**SEDIMENTATION**

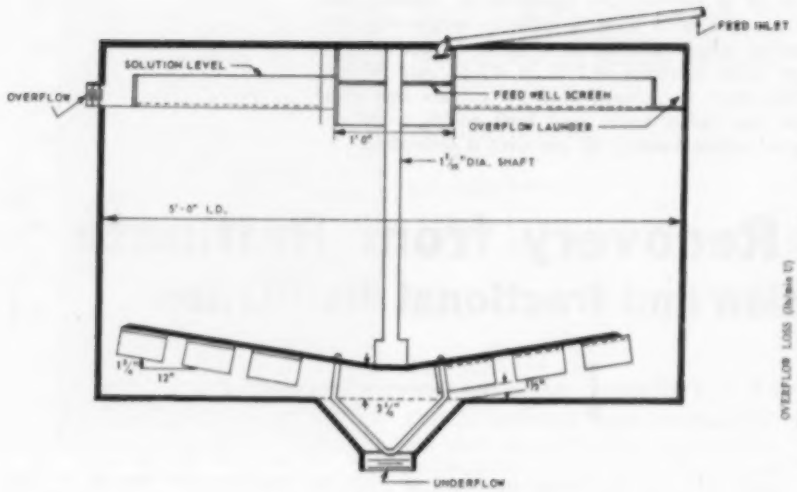


Fig. 2. Thickener details.

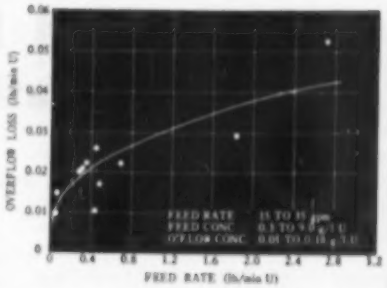


Fig. 3. Loss of U in overflow (magnesia-precipitated feed).

satisfactory polishing filter operation. Clear overflows (0.1 to 0.2 g. U/l.) were reported over the entire range of feed rates. Good overflow clarity was obtained even with high levels of solids in the underflow. With the more concentrated feeds, the insoluble solids content of the underflow was raised to 30 or 40% by weight, and the uranium content to between 10 to 20%.

Because of potential savings in chemical costs, hydrated lime was used in some runs for neutralization of the thickener feed (Table 2). There was a significant difference in the amount of uranium lost in the overflow. With the use of lime alone, feed rates comparable to the lowest of those in which magnesium was used resulted in overflow losses of from 10 to 68% of the uranium fed. It was concluded that the solids content of the underflow was too low to permit practical application of lime as a neutralizing agent.

A mixture of half lime and half magnesia was used in a few runs (Table 2). High rates with this feed did not produce unusually high overflow losses, but the underflow solids content was somewhat below that obtainable with magnesia. Lower efficiency in the filtration of the thickener overflow would probably offset any advantage that might be gained by the use of lime.

**Table 1.—Operating Data, Magnesia-Precipitated Feed.**

| run no. | rates (gal./min.) feed | overflow | underflow | rates (lb./min. U) feed | overflow | underflow | U content (wt. %) feed | underflow | U (g./l.) overflow | overflow loss % U fed |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 15 | ..... | 1.9 | 1.1 | 0.017 | 1.6 | 0.09 | 8.2 | 0.10 | 2 |
| 2 | 10 | 16.0 | 1.4 | 0.70 | 0.014 | 0.37 | 0.88 | 2.8 | 0.10 | 2 |
| 3 | 15 | 18.7 | 1.3 | 0.82 | 0.030 | 0.095 | 0.41 | 0.81 | 0.23 | 4 |
| 4 | 15 | 14.8 | 1.2 | 0.34 | 0.022 | 0.064 | 0.27 | 0.80 | 0.18 | 6 |
| 5 | 19 | 19.0 | 2.0 | 0.85 | 0.009 | 0.14 | 0.02 | 0.84 | 0.083 | 33 |
| 6 | 19 | 18.0 | 2.2 | 0.87 | 0.015 | 0.23 | 0.04 | 1.2 | 0.10 | 21 |
| 7 | 19 | ..... | 1.9 | 0.44 | ..... | 0.68 | 0.28 | 0.42 | 0.17 | ... |
| 8 | 19 | ..... | 1.6 | 0.28 | ..... | 0.47 | 0.24 | 2.5 | 0.09 | ... |
| 9 | 19 | 21.4 | 0.39 | 0.81 | 0.038 | 0.66 | 0.51 | 11.8 | 0.21 | 5 |
| 10 | 19 | 19.2 | 0.73 | 0.70 | 0.022 | 0.67 | 0.44 | 10.5 | 0.14 | 3 |
| 11 | 19 | 19.0 | 0.60 | 0.69 | 0.017 | 0.64 | 0.31 | 7.0 | 0.11 | 3 |
| 12 | 19 | 18.2 | 0.61 | 0.15 | 0.014 | 0.23 | 0.09 | 3.7 | 0.09 | 9 |
| 13 | 19 | 18.6 | 0.30 | 0.30 | 0.014 | 0.37 | 0.19 | 6.0 | 0.09 | 5 |
| 15 | 23 | ..... | 0.76 | 0.55 | ..... | 0.65 | 0.36 | 9.3 | 0.33 | ... |
| 16 | 23 | ..... | 1.3 | 0.64 | ..... | 0.81 | 0.31 | 8.5 | 0.00 | ... |
| 17 | 23 | ..... | 0.68 | 0.33 | ..... | 0.27 | 0.16 | 4.7 | 0.14 | ... |
| 18 | 23 | ..... | 1.4 | 0.33 | ..... | 0.30 | 0.12 | 3.1 | 0.06 | ... |
| 19 | 23 | ..... | 0.33 | 0.35 | ..... | 0.33 | 0.17 | 6.1 | 0.08 | ... |
| 20 | 23 | ..... | 0.78 | 0.34 | ..... | 0.11 | 0.16 | 1.6 | 0.10 | ... |
| 21 | 23 | ..... | 0.80 | 0.19 | ..... | 0.073 | 0.09 | 1.9 | 0.11 | ... |
| 22 | 23 | ..... | 1.9 | 0.38 | ..... | 0.15 | 0.13 | 0.98 | 0.04 | ... |
| 23 | 18 | ..... | 0.47 | 0.23 | ..... | 0.23 | 0.10 | 3.9 | 0.10 | ... |
| 24 | 15 | ..... | 0.50 | 0.32 | ..... | 0.46 | 0.41 | 9.1 | 0.09 | ... |
| 25 | 15 | ..... | 0.62 | 0.50 | ..... | 0.75 | 0.43 | 9.1 | 0.000 | ... |
| 26 | 19 | ..... | 0.37 | 1.1 | ..... | 0.39 | 0.66 | 10.6 | 0.16 | ... |
| 27 | 19 | ..... | 0.68 | 0.77 | ..... | 0.66 | 0.48 | 9.5 | 0.35 | ... |
| 28 | 19 | ..... | 0.60 | 0.32 | ..... | 0.45 | 0.30 | 7.3 | 0.20 | ... |
| 29 | 23 | ..... | 0.62 | 0.69 | ..... | 2.9 | 0.36 | 10.8 | 0.29 | ... |
| 30 | 23 | ..... | 0.83 | 0.71 | ..... | 0.20 | 0.27 | 5.7 | 0.19 | ... |
| 38 | 24.4 | 22.1 | 0.18 | 0.063 | 0.0096 | 0.045 | 0.031 | 2.0 | 0.00 | 15 |
| 41 | 25.3 | 23.2 | 0.26 | 0.46 | 0.011 | 0.083 | 0.21 | 2.6 | 0.06 | 2 |
| 42 | 26.4 | 29.8 | 0.29 | 0.16 | 0.017 | 0.10 | 0.08 | 3.8 | 0.07 | 9 |
| 43 | 28.5 | 26.6 | 0.33 | 0.28 | 0.021 | 0.20 | 0.12 | 8.0 | 0.09 | 9 |
| 44 | 30.6 | ..... | 0.80 | 0.18 | ..... | 0.16 | 0.07 | 2.2 | 0.08 | ... |
| 45 | 32.7 | 31.4 | 1.4 | 0.38 | 0.022 | 0.53 | 0.14 | 4.0 | 0.09 | 6 |
| 46 | 28.1 | 25.0 | 0.67 | 1.9 | 0.014 | 1.4 | 0.82 | 17.8 | 0.07 | 1 |
| 47 | 28.9 | 25.8 | 0.38 | 1.0 | 0.051 | 0.90 | 0.43 | 20.3 | 0.087 | 8 |
| 48 | 34.8 | 33.0 | 0.66 | 2.7 | 0.052 | 0.92 | 0.04 | 13.0 | 0.10 | 2 |
| 49 | 27.7 | 27.0 | 0.77 | 1.8 | 0.029 | 1.4 | 0.8 | 16.6 | 0.13 | 2 |
| 50 | 36.9 | 36.5 | 0.33 | 0.45 | 0.026 | 0.84 | 0.2 | 8.4 | 0.12 | 6 |

**Table 2.—Operating Data, Lime, and Lime-Magnesia Precipitated Feed.**

| run no. | rates (gal./min.) feed | overflow | underflow | rates (lb./min. U) feed | overflow | underflow | U content (wt. %) feed | underflow | U (g./l.) overflow | overflow loss % U fed |
|---|---|---|---|---|---|---|---|---|---|---|
| *Lime only* | | | | | | | | | | |
| 31 | 1.3 | 1.0 | 0.33 | 0.013 | 0.0004 | 0.010 | 0.12 | 0.38 | 0.040 | 3 |
| 33 | 0.7 | ..... | 0.77 | 0.10 | 0.0023 | 0.14 | 0.21 | 2.2 | 0.027 | 2 |
| 34 | 0.3 | ..... | 0.27 | 0.13 | 0.0009 | 0.054 | 0.29 | 1.3 | 0.022 | 1 |
| 35 | 0.1 | ..... | 0.12 | 0.17 | 0.0005 | 0.052 | 0.45 | 24.0 | 0.002 | 1 |
| 37 | 0.7 | ..... | 0.27 | 0.026 | 0.0096 | 0.040 | 0.054 | 0.55 | 0.13 | 37 |
| 57 | 12.9 | 13.8 | 0.27 | 0.19 | 0.008 | 0.016 | 0.10 | 1.0 | 0.07 | 4 |
| 58 | 18.7 | 16.5 | 0.23 | 0.14 | 0.047 | 0.027 | 0.09 | 1.4 | 0.34 | 33 |
| 59 | 13.0 | 14.4 | 0.28 | 0.055 | 0.009 | 0.014 | 0.05 | 0.7 | 0.06 | 16 |
| 60 | 15.0 | 14.1 | 0.12 | 0.16 | 0.014 | ..... | 0.11 | 0.6 | 1.16 | 10 |
| 61 | 15.3 | 14.3 | 0.41 | 0.15 | 0.030 | ..... | 0.12 | 1.0 | 0.32 | 23 |
| 62 | 16.0 | 14.3 | ..... | 0.47 | 0.17 | ..... | 0.34 | 2.7 | 1.4 | 36 |
| 63 | 16.1 | 14.6 | 0.22 | 0.34 | 0.23 | 0.048 | 0.25 | 2.2 | 1.9 | 68 |
| 64 | 14.9 | 15.3 | 0.25 | 0.082 | 0.014 | 0.025 | 0.07 | 1.2 | 0.11 | 17 |
| 66 | 18. | 15.3 | ..... | 0.43 | 0.15 | ..... | 0.29 | 1.7 | 1.2 | 35 |
| *Lime and magnesia* | | | | | | | | | | |
| 51 | 25.8 | 24.9 | 0.69 | 0.84 | 0.033 | 0.34 | 0.29 | 7.1 | 0.16 | 4 |
| 52 | 22.6 | 20.8 | 0.42 | 1.51 | 0.017 | 0.77 | 0.8 | 10.1 | 0.10 | 1 |
| 53 | 23.7 | 22.4 | 0.57 | 0.51 | 0.019 | 0.18 | 0.36 | 3.6 | 0.10 | 3 |
| 54 | 22.2 | 22.0 | 0.65 | 0.73 | 0.024 | 0.90 | 0.39 | 13.0 | 0.13 | 3 |
| 55 | 25.9 | ..... | 0.56 | 0.66 | ..... | 0.64 | 0.40 | 10.6 | 0.054 | ... |
| 56 | 23.6 | 20.8 | 0.20 | 0.63 | 0.038 | 0.088 | 0.33 | 5.3 | 0.22 | 6 |

### Literature Cited

1. Arnold, D. S., C. E. Polson, and E. S. Noe, Preprint No. 113; paper presented at the Nuclear Engineering Science Congress, Cleveland (Dec. 13, 1955). *Mining Eng.* **8**, 608-610 (1956).

*Presented at A.I.Ch.E. meeting, Pittsburgh, Pennsylvania.*

Operation of a twelve-plate fractionating column with nitric acid vapor feed from a raffinate evaporator has given over-all column efficiencies of 33 to 54 per cent for superficial vapor velocities of 0.57 to 4.5 ft./sec. With a reasonable effort to achieve optimum column operating conditions, i.e., reflux ratios and feed points, a column efficiency of approximately 50 per cent is indicated.

# Nitric Acid Recovery from Raffinate
## by evaporation and fractional distillation

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Recent development of processes for recovering and refining or separating various elements, that is, uranium (*1, 4, 16*), hafnium (*10*), zirconium (*10*), thorium (*7*), manganese (*13*), and plutonium (*4*) from nitric acid solution have pointed up the need for a method of separating and concentrating nitric acid from the residue or raffinate stream. A significant excess of free acid may be used to improve leaching and extraction efficiency. Problems associated with evaporation and concentration of this free acid from dilute solution in extraction raffinates have been investigated in laboratory and plant-scale equipment. The results constitute a new area of industrial nitric acid technology since most nitric acid concentration facilities are devoted to the production of highly concentrated acid from the azeotrope or from an absorber product of comparable strength.

Physical and chemical data have been determined and reported by many investigators. Atmospheric vapor-liquid equilibria data have been reported for the nitric acid-water system by Perry (*14*) and by Simmons and Canny (*17*). Hagerty and Hixson (*8*) have developed data on vapor-liquid equilibria of nitric acid solutions containing the chloride ion at atmospheric pressure. These data have been extended to subatmospheric pressures by Crooks *et al* (*3*). Thermal properties of the system have been reviewed and reported by Egan (*5*) and by Bump and Sibbitt (*2*).

### Equipment

The equipment upon which this report is based consisted of a plant-scale evaporator, fractionator, and sparge tank (Figure 1).

The evaporator (forced circulation) consisted of a two-pass, horizontal shell-and-tube exchanger, a centrifugal pump, and a flash chamber. Approximately 90% of the raffinate was vaporized in this unit with the remaining 10% withdrawn as a raffinate concentrate.

Vapors from the evaporator were fed to a twelve-plate bubble-cap tower for concentration of the nitric acid. This tower was equipped with a steam heated external reboiler and with a surface condenser. The 3-in. diam., 3-in. high bubble caps with forty-two slots (3/32 in. × 13/16 in., 3/16 in. above the plate floor) per cap were installed on 4¼-in. centers over 83% of the plate area. The other 17% of each plate was devoted to overflow weirs, calming zones, and downcomer pipes. A saw-tooth-type overflow weir maintained a 1-in. static liquid seal over the top of the slots. The caps were mounted over 2⅛ in. diam. × 2-in. high chimneys. A plate spacing of 24 in. was used in construction of the tower. The unit was constructed of Type 347 and Type 309 Cb stainless steel with the latter used where the greatest corrosion effects were expected. Liquid sample taps were located at the discharge point of the downcomers from alternate plates.

The liquid from the downcomers from plate No. 9 was diverted through a heat exchanger to an insulated tank where it was sparged with a 1% concentration of ozone in air to oxidize and remove the chlorides as free chlorine. The acid was pumped back to plate No. 8 through a second heat exchanger. The ozone was produced by a corona discharge in air in Welsbach ozone generators and introduced into the bottom of the acid pool in the tank through porous Kel-F diffusers.

### Test Procedure

An inventory of essentially uniform raffinate was accumulated in storage tanks during operations before the initiation of the formal test. This raffinate was carefully mixed, sampled, and analyzed, then pumped at a controlled rate to the evaporator.

Vapors from the evaporator were sampled by a continuous bleed of vapor through a small total condenser at the feed nozzle to the fractionating tower. The vapor was metered with an orifice and charged to the column between plate No. 6 and plate No. 7. Reboiler steam flow was controlled instrumentally by the temperature of the pool in the bottom of the tower. The reflux was pumped at a constant rate to the top plate of the tower through a rotameter. A steady removal of concentrated acid from the bottom of the tower was similarly maintained through a rotameter. Air-ozone at a constant flow rate was charged to the diffusers of the sparge tank. As a check on the liquid flowmeters, the total volumes charged and collected during the test were determined by measuring liquid levels in storage tanks, surge tanks, and product receivers.

**Table 1.—Nitric Acid Concentrator Performance**

| Test no. | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1. $HNO_3$ concentration, mole fraction: | | | | |
| Vapor feed, $y_f$ | 0.052 | 0.035 | 0.033 | 0.023 |
| Liquid feed, $x_f$ | 0.131 | None | None | None |
| Distillate, $x_d$ | 0.0011 | 0.0001 | 0.0009 | 0.0014 |
| Product, $x_b$ | 0.332 | 0.274 | 0.252 | 0.325 |
| 2. Terminal reflux ratios: | | | | |
| Enriching section, $(V/L)_n$ | 3.16 | 3.32 | 4.63 | 2.53 |
| Stripping section, $(V/L)_m$ | 0.64 | 0.70 | 0.55 | 0.90 |
| 3. Number of theoretical plates: | | | | |
| $N_t$ | 6.5 | 5.0 | 5.5 | 4.0 |
| 4. Over-all column efficiency: | | | | |
| $E_o$ | 54% | 42% | 46% | 33% |
| 5. Superficial vapor velocity, ft./sec.: | | | | |
| Enriching section, $v_n$ | 2.1 | 4.0 | 4.5 | 4.7 |
| Stripping section, $v_m$ | 0.57 | 1.1 | 0.65 | 2.2 |

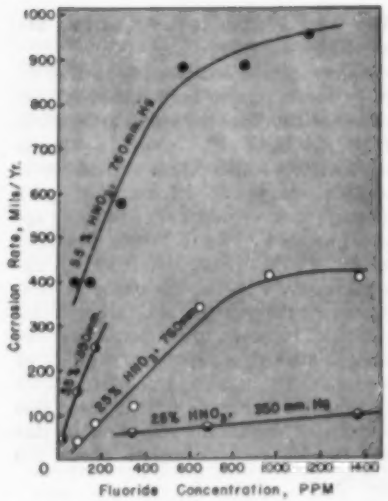


Fig. 2. Effect of fluoride upon the corrosion of Type 347 stainless steel in boiling nitric acid (12).

Since each of these tests was superimposed on routine production operations, the system was in an essentially steady-state condition at the start of the test. However, to insure the steady-state requirement for the tests, the system was operated for 6 to 8 hr. on the special raffinate before the sampling program was initiated. Hourly samples were taken until steady-state operation had been demonstrated, at which time the test was terminated.

#### Analytical Procedure

The $HNO_3$ concentrations were determined by titration of the sample with 1*N* NaOH solution.

Chlorides were determined by turbidimetric measurement in a Beckman DU spectrophotometer of a silver chloride suspension prepared by adding silver nitrate solution to a properly diluted sample.

Fluorides were measured by an adaptation of the colorimetric Thoron method (*9*). This modified method consists of adjusting the acidity of the sample to 3.0*N* $HNO_3$. The effect of this $HNO_3$ concentration on the Thoron method is then considered in calculating the fluoride concentration of the original sample.

#### Calculation of Results

The number of theoretical plates, $N_t$, was determined for each test by the Ponchon-Savarit method (*15*), that is, graphical determination of operating lines from the enthalpy-concentration chart for nitric acid and water followed by "stepping off" the theoretical plates with these operating lines on the vapor-liquid equilibrium diagram. Moderate curvature of the operating line was found in some instances. The reflux ratios reported are those for the ends of the tower, that is, at the top

$$\frac{(V)}{(L)n} = \frac{R+D}{R}$$

and at the bottom

$$\frac{(V)}{(L)m} = \frac{V_r}{V_r+B}$$

Over-all column efficiencies were calculated as

$$E_o = \frac{N_t}{N_p} = \frac{N_t}{12}$$

Column superficial vapor velocities ($v$) are based upon total cross-sectional area of the tower. Since 17% of the plate was devoted to downcomers and overflow weirs, 83% of the area was left for the active contacting zone.

### Results

#### NITRIC ACID CONCENTRATOR EFFICIENCY

Over-all column efficiencies for the twelve-plate nitric acid concentrator tower are reported in Table 1. The highest column efficiency, 54% in test No. 1, was achieved with a vapor feed from the raffinate evaporator to plate No. 8 and a liquid nitric acid feed to plate No. 6. Lower column efficiencies were found in tests No. 2, 3, and 4 where only vapor feed was used and where the nitric acid concentration of the feed was lower. These low column efficiencies may be due to high variation in reflux ratios and in vapor velocities between the enriching section and the stripping section and to the fixed location of the feed plate. Although a vapor feed manifold was provided in the design and installation of this unit, it has not been considered practical to change the feed point to accommodate normal variations in nitric acid concentration of the vapor feed.

In the case of test No. 4, a malfunction in the stripping section was definitely established by the extremely low pressure drop of 1 in. of water for the six plates, whereas a 15-in. pressure drop was measured across the six plates in the enriching section. It is concluded that the liquid seals on the stripping section plates were lost during this test.

#### NITRIC ACID CONCENTRATOR CORROSION

By virtue of the highly corrosive nature of chloride and fluorides in boiling concentrated (50 to 60% $HNO_3$ by wt.) nitric acid and because of the presence of small but significant quantities of these halides in the raffinates, special attention must be devoted to corrosion in the concentrator. Figure 2 presents results of laboratory tests (*12*) of the cor-

unit operations in nuclear engineering

## SOLVENT EXTRACTION

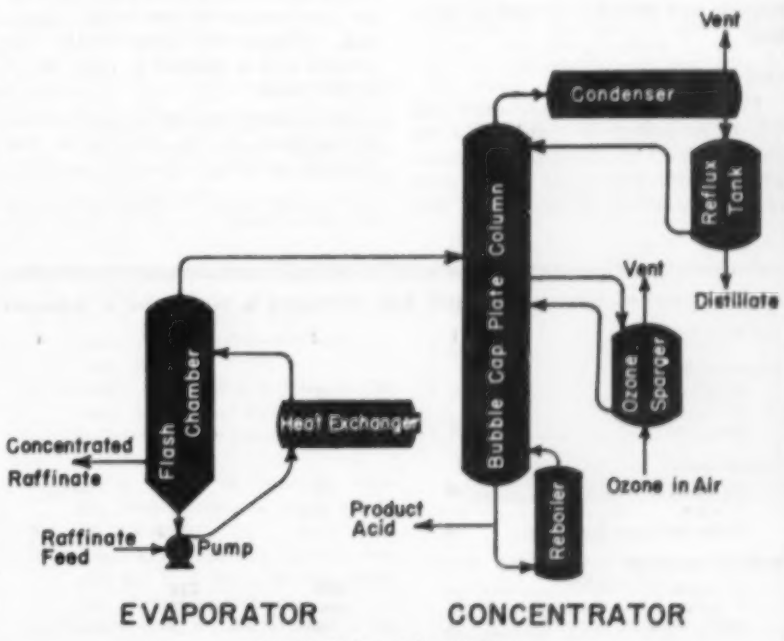


Fig. 1. Equipment flow diagram.

**Table 2.—Chloride and Fluoride Distribution in Nitric Acid Concentrator**

| Sample | Overhead vapor | Plate No. 9 | Plate No. 7 | Plate No. 5 | Plate No. 3 | Bottoms product |
|---|---|---|---|---|---|---|
| **Test No. 5:** | | | | | | |
| Cl, p.p.m. | | 280 | 335 | 360 | 375 | 58 |
| $HNO_3$, wt.% | | 16 | 16 | 27 | 32 | 9 |
| **Test No. 6:** | | | | | | |
| Cl, p.p.m. | | 140 | 228 | 400 | 48 | 3 |
| $HNO_3$, wt.% | | 1 | 7 | 31 | 50 | 48 |
| **Test No. 7:** | | | | | | |
| Cl, p.p.m. | 20 | 85 | 30 | 25 | 11 | 2 |
| $HNO_3$, wt.% | 1 | 21 | 33 | 40 | 45 | 60 |
| **Test No. 1:** | | | | | | |
| Cl, p.p.m. | 60 | 166 | ..... | ..... | ..... | 11 |
| $HNO_3$, wt.% | 0.39 | 13 | ..... | ..... | ..... | 63.2 |
| **Test No. 2:** | | | | | | |
| Cl, p.p.m. | 50 | 349 | 234 | 121 | 34 | 3 |
| F, p.p.m. | 8.3 | 76.2 | 19 | 6.2 | 11.5 | 48 |
| $HNO_3$, wt.% | 0.038 | 13.5 | 30.6 | 35.2 | 39.7 | 56.2 |
| **Test No. 3:** | | | | | | |
| Cl, p.p.m. | 11.4 | 178 | 40 | 32 | 19 | 1.5 |
| F, p.p.m. | 11.4 | 56.8 | 6.7 | 10.1 | 4.0 | 10.7 |
| $HNO_3$, wt.% | 0.3 | 22.1 | 31.0 | 34.0 | 36.2 | 54.3 |

rosion of Type 347 stainless steel as a function of $HNO_3$ concentration and of fluoride concentration at the boiling point under absolute pressures of 350 mm. Hg and 760 mm. Hg. The lower temperatures associated with the reduced pressures result in appreciably lower corrosion rates. However, the importance of minimizing the fluoride concentration in the bottom of the tower is emphasized by these data even under vacuum operation. High corrosion rates result from similar chloride concentrations in the presence of boiling nitric acid.

### CHLORIDE CONTROL

From vapor-liquid equilibrium data (*3, 8*) as plotted in Figure 3, it has been predicted that chlorides would concentrate near the middle of the nitric acid fractionator. Experimental data from various concentrator tests, as listed in Table 2, demonstrate the build-up of chlorides within the tower.

Evaporator tests have shown that approximately one half of the chloride present in the raffinate passes to the concentrator in the evaporator overhead product. This would lead to an accumulation of chlorides in the middle of the concentrator unless these are removed through a side stream. This chloride removal is accomplished by an air-ozone sparge of the liquid from plate No. 9 of the concentrator in the ozone sparge tank (Figure 1) from which the sparged acid is pumped to plate No. 8 of the tower.

The chloride removal is accomplished by oxidation of the chloride to free chlorine according to the equation (*18*):

$$2H^+ + 2Cl^- + O_3 = O_2 + H_2O + Cl_2$$

**Table 3. Fluoride, Chloride, and Nitric Acid Distribution in Evaporation of Raffinates**

| Test No. | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| **Evaporator feed** | | | | |
| Cl, p.p.m. | .. | 143 | 81 | ... |
| F, p.p.m. | .. | 172 | 348 | ... |
| $HNO_3$, wt.% | .. | 11.5 | 11.6 | .. |
| **Product vapor** | | | | |
| Cl, p.p.m. | 48 | 73 | 38 | ... |
| F, p.p.m. | .. | 15.4 | 18 | ... |
| $HNO_3$, wt.% | 16 | 11.0 | 10.5 | 7.5 |
| **Raffinate concentrate** | | | | |
| Cl, p.p.m. | .. | 694 | 224 | ... |
| F, p.p.m. | .. | 1,660 | 2,130 | ... |
| $HNO_3$, wt.% | .. | 8 | 3.9 | ... |

The free chlorine is desorbed and removed by the sparge air.

Sparging tests indicate 160 to 170° F. to be the optimum temperature for removal of chlorides from a 15 to 20 wt.% $HNO_3$ with a 1% ozone in air-gas mixture. At a 300 p.p.m. chloride level with a sparge of 1.2 cu.ft. of gas/(min.)(sq.ft. of tank area) through approximately 8 ft. depth (static measure) of acid (20% $HNO_3$ and 165° F.), approximately 75% of the ozone is consumed in the sparge tank through oxidation of chloride, ozone decomposition, and possible side reactions. Results of a batch test of ozone sparge performance is indicated in Figure 4. It is noted that there is a significant reduction in rate of chloride removal below about 200 p.p.m.

### FLUORIDE CONTROL

Fluorides, as might be anticipated, accumulate in the concentrator in a manner similar to the chlorides (Table 2), however, the ozone sparge is ineffective on the fluorides. A technique has been developed (*11*) for complexing the fluorides in the raffinates with aluminum, thereby reducing their volatility. This procedure results in retention of more than 90% of the fluorides in the raffinate with less than 10% being vaporized to the concentrator. Typical data are shown in Table 3 and Figure 5. A ratio of five parts of aluminum per part of fluoride (by weight) has been found sufficient to suppress the fluoride volatility. Iron, calcium, and magnesium exert similar volatility suppression on the fluorides but are not nearly so effective as aluminum.

From Figures 2 and 5, a limit (maximum) of the order of 100 to 200 p.p.m. fluoride on the concentrator plates, which have nitric acid concentrations of 10 to 25% (by weight), is considered necessary for corrosion control with operation of the concentrator under atmospheric pressure. Laboratory tests (*12*) have shown that aluminum complexing of the fluoride reduces corrosion of stainless steel by the fluoride-nitric acid solution. Experience with production operation of the raffinate evaporator has confirmed these tests.

With the use of a 5:1 wt. ratio of aluminum to fluoride in the raffinate feed stream to the evaporator, a raffinate fluoride level of 400 to 600 p.p.m. has been accommodated without exceeding a level of 150 p.p.m. in the concentrator in sustained operation of the nitric acid recovery facility.

Laboratory tests (*11*) supported by limited plant data indicate that in the absence of volatility suppressing agents, approximately 80% of the fluoride in

the evaporator feed goes to the concentrator. Data for a few isolated cases of similar conditions in plant operation confirm the high fluoride volatility in the absence of the complexing metal ions.

### PREVENTIVE MAINTENANCE PROGRAM

Since appreciable corrosion of stainless steel occurs in boiling nitric acid solutions at atmospheric pressure (Figure 2), an aggressive preventive maintenance program is needed. A schedule of periodic shutdowns (at five to six-week intervals) for internal inspection and repair has been followed. These have indicated that the welds and reboiler tubes of the concentrator are the major points of corrosion attack. Welds are repaired by grinding and refilling with type 309 Cb stainless steel filler rods with the use of heliarc techniques. Replacement of reboiler tubes with a minimum of plant downtime is achieved by installation of a spare reboiler tube bundle when inspection indicates need for retubing the unit which has been in service.

### ADVANTAGES OF VACUUM OPERATION

Because of the heavy maintenance program associated with operation of the system at atmospheric pressure, a study of conversion to vacuum operation was initiated. From laboratory tests, a substantial reduction in corrosion rates is to be expected at the lower operating temperatures associated with the reduced pressures. Data on nitric acid and on chloride vapor-liquid equilibria (3) demonstrate that no sacrifice in column performance is to be expected from these considerations. The problem of achieving lower temperatures and thereby lower corrosion rates therefore resolves itself into one of developing plate and bubble-cap design details to provide adequate column flow rates and efficiencies under vacuum operation. Studies based upon the data presented in this paper suggest that this approach is feasible and the system as described, except for installation of an entrainment separator in the vapor line from the evaporator flash chamber and for a redesign of concentrator plate details for vacuum operation, is recommended.

### Notation

- $B$ = product acid (bottoms) flow rate, lb. moles/(hr.)(sq.ft.)
- $D$ = distillate flow rate, lb. moles/(hr.)(sq.ft.)
- $E$ = column efficiency
- $L$ = liquid flow rate in column, lb.-moles/(hr.)(sq.ft.)
- $R$ = reflux flow rate, lb.-moles/(hr.)(sq.ft.)
- $V$ = vapor flow rate in column, lb.-moles/(hr.)(sq.ft.)
- $v$ = superficial vapor velocity based on total column cross-sectional area, ft./sec.
- $x$ = mole fraction in liquid
- $y$ = mole fraction in vapor

*Subscripts*

- $b$ = product acid (bottoms) from concentrator
- $d$ = distillate from concentrator
- $f$ = feed to concentrator
- $m$ = stripping section of concentrator
- $n$ = enriching section of concentrator
- $o$ = over-all value for entire column
- $p$ = actual plates in concentrator
- $r$ = from concentrator reboiler
- $t$ = theoretical plates

### Literature Cited


1. Arnold, D. S., C. E. Polson, and E. S. Noé, "Production of Uranium Metal" presented before Nuclear Engineering and Science Congress, Cleveland, Ohio (December 13, 1955). *Mining Eng.*, **8**, 608 (1956).
2. Bump, T. R., and W. L. Sibbitt, *Ind. Eng. Chem.*, **47**, 1665 (1955).
3. Crooks, R. C., R. Q. Wilson, A. E. Bearse, and R. B. Filbert, Jr., BMI-978 (1955).
4. Culler, F. L., *et al.*, *Chem. Eng. Progr.*, **51**, 430 (1955).
5. Egan, E. P., *Ind. Eng. Chem.*, **37**, 303 (1945).
6. Gessiness, B. G., private communication (1955).
7. Gresky, A. T., *et al.*, *Chem. Eng. Progr.*, **51**, 460 (1955).
8. Hagerty, P. F., and A. N. Hixson, TID-5146 (1953).
9. Horton, A. D., P. F. Thomason, and F. J. Miller, *Analytical Chem.*, **24**, 548 (1952).
10. Hudswell, F., and J. M. Hutcheon, Paper presented at Internat. Conf. Peaceful Uses of Atomic Energy (August, 1955).
11. Johnson, E. R., and E. O. Rutenkroger, NLCO-576 (1955).
12. Meyer, F. H., Jr., Private Communication (1955).
13. Nessen, E. S., *Ind. Eng. Chem.*, **43**, 1695 (1951).
14. Perry, J. H., "Chemical Engineers' Handbook," 3 ed., McGraw-Hill Book Company, New York (1950).
15. Robinson, C. S., and E. R. Gilliland, "Elements of Fractional Distillation," 4 ed., McGraw-Hill Book Company, New York (1950).
16. Sege, G., and F. W. Woodfield, *Chem. Eng. Progr., Symposium Series*, No. 13, **50**, 179 (1954).
17. Simmons, L. M., and M. J. Canny, *J. Proc. Roy. Soc. N. S. Wales*, **83**, 238 (1949); *CA*, **45**, 10002 g (1951).
18. Yeatts, L. B. B., Jr., and H. Taube, *J. Am. Chem. Soc.*, **71**, 4100 (1949).


unit operations in nuclear engineering

**SOLVENT EXTRACTION**

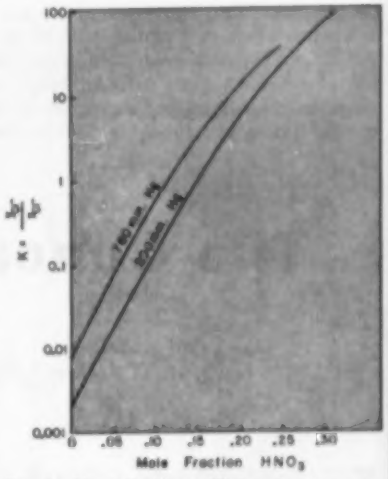


Fig. 3. Vapor-liquid equilibrium for low concentrations (mole fraction of $7 \times 10^{-4}$ to $1200 \times 10^{-4}$) of chloride in nitric acid (3).

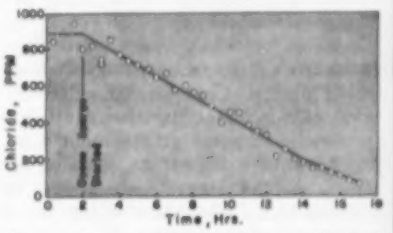


Fig. 4. Removal of chloride from nitric acid, batch test of ozone sparging unit. (Test conditions: 20% $HNO_3$, 155-165° F., 1% $O_3$ in air, 1.2 cu.ft. gas/min./sq.ft. tank area, 7 ft. acid depth.)

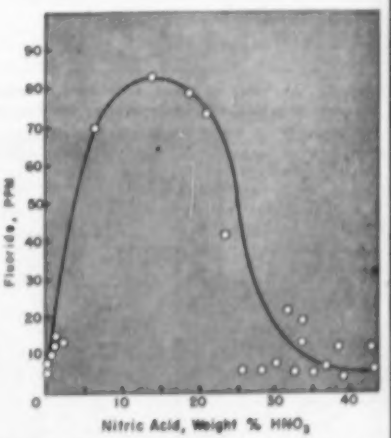


Fig. 5. Distribution of fluoride in nitric acid concentrator.

*Presented at A.I.Ch.E. meeting, Pittsburgh, Pennsylvania.*

In plants for reprocessing reactor fuels, costs for the process building generally exceed the delivered cost of the process equipment by a factor of two to four (4). This high building-to-equipment cost ratio arises from the shielding required to protect plant personnel from radiation. This shielding consists of massive concrete walls and roof slabs 5 ft. or more in thickness for enclosing the process canyon.

For nuclear applications, the use of tall equipment such as solvent extraction contactor towers requires tall, silo-like concrete shielding structures which are costly. The pulse column, which was invented in 1935 by a Dutch engineer, Van Dijck (5), was introduced about six years ago as a means of reducing the vertical height required for multistage continuous solvent extraction contacting. The pulse column has required roughly 50% of the headroom necessary for a packed column of sufficient length to do the same extraction job (3).

In some more recent applications of solvent extraction processes, 40 to 50 ft. of headroom would have been required in order to accommodate the required length of pulse column for accomplishing the desired separation and purification. The *concatenated pulse column*, a modification of the pulse column, was conceived as a means of shortening the vertical space requirement by dividing the pulse column into short, concatenated sections. For nonnuclear separations applications, the concatenated column may show attractive economic advantages in reducing column height, particularly from a maintenance cost standpoint.

# The Concatenated Pulse Column

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Operated by Union Carbide Nuclear Company

The concatenated pulse column is a vertical-type solvent extraction contactor designed to provide maximum contacting length without requiring excessive structural headroom (that is, exceeding that of other equipment in a radiochemical solvent extraction processing plant). Concatenated pulse columns of 5-in. diam. have been installed in a radio-chemical process pilot plant and have been successfully operated remotely behind concrete shielding. In addition to the pilot plant application, a set of two experimental 12-in. diam. packed columns, each containing a 50-ft. packed height, was repiped for operation as a concatenated pulse column in large-scale hydrodynamic tests.

The concatenated pulse column can provide the equivalent contacting length of an ordinary (tall) pulse column without the use of more than one-third to one-half the headroom required for the tall column. This is accomplished by taking, in effect, sections of the tall column, mounting these sections in parallel vertically, and connecting them in series. The series-connection is made with pairs of tubes appropriately check-valved to accommodate the over-all countercurrent flow of two immiscible fluids. Like the corresponding tall pulse column, the concatenated contactor requires only one pulse generator, and the operation of both contactors is similar. It is the cyclical pulse action which makes this serpentine circuit for the liquid-liquid system feasible and of practical value for countercurrent extraction operations.

Higher flow capacity (10 to 40%) has been observed with the concatenated pulse column vs. the tall pulse column of the same column diameter. While a definitive comparison of mass transfer performance in the concatenated pulse column vs. the tall pulse column was not attempted in the tests made by the authors, it is believed apparent that the concatenated column is at least as effective, if not somewhat more so, than the corresponding tall column of the same total length of packed contacting section.

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Fig. 1. Schematic sketch of a three-section concatenated pulse column in quiescence (incorporating floating-disc check valves).

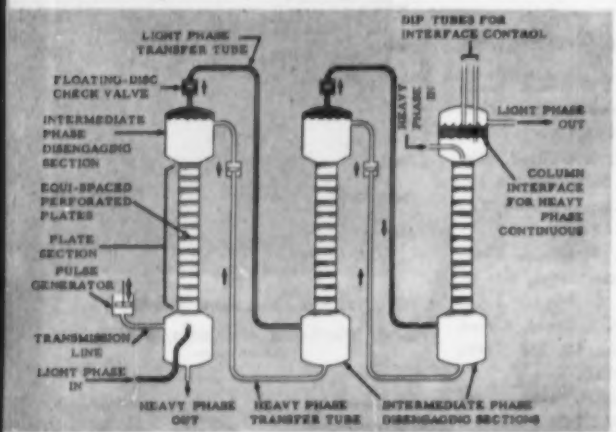
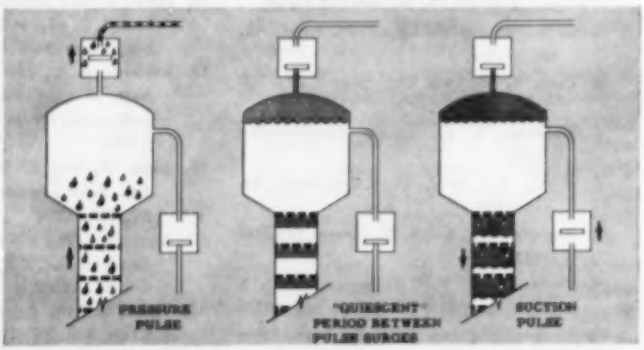



Fig. 2. Simple schematic illustration of major stages of pulse cycle in a concatenated pulse column, showing also performance of floating-disc check valve. In practice, dispersions are more complete and the "quiescent" period is not as distinct as sketched. Sketches are typical of pulsing at about 20 cycles/min., with total stream flow of about 100 gal./(sq.ft.)(hr.) through the column.



#### Description of Column and Accessories

The concatenated pulse column employs essentially the same pulse generator and the same internal contacting media (that is, perforated plate cartridges or other suitable packing) as the tall pulse column. The concatenated pulse column consists of a series of two or more relatively short contacting sections, mounted in parallel vertically, and usually of the same height (see Figure 1). The sections are connected by pairs of tubes each of which is appropriately provided with a check valve to facilitate the over-all countercurrent flow of the two immiscible liquids through the contactor. Hence, liquid flow in the concatenated pulse column proceeds in a vertical, sinuous path, up and down through the several sections of the contactor and transfer tubes, as contrasted with the straight vertical flow in the tall pulse column.

#### Operational Procedure

Externally, operation of the concatenated pulse column is essentially identical with that of the tall pulse column. Internally, the pulse action in the concatenated pulse column not only causes the countercurrent contacting in the packed sections but also, with the aid of the check valves and transfer tubes, accomplishes the countercurrent transfer of each phase between sections. On the pressure pulse (see Figure 2), the lighter phase at the top of each section is passed through the light-phase transfer tube running from the top of each contactor section to the bottom of the next section upstream, whereas on the suction stroke of the pulse generator, the heavier phase at the bottom of each section flows through the heavy-phase tube running from the bottom of each section to the top of the next section downstream. The check valve in each light-phase transfer tube opens during the pressure pulse, while the check valve in each heavy-phase transfer tube closes to prevent a back-surge of the heavy phase, and conversely for the suction pulse stroke. Without the system of transfer tubes and oppositely oriented check valves the countercurrent flow of the two immiscible liquids cannot occur.

A floating-disc check valve was finally selected during the development of the contactor as the simplest, apparently fool proof design for use in the transfer tubes. Although it is not necessary that the valve be leaktight (an improved valve (*1*) has been designed incorporating a weep hole and a spring to eliminate slamming of the disc when the valve shuts), it is necessary that the valve be capable of providing long-term maintenance-free operation since each valve would undergo roughly 30 million cycles in a year of continuous column operation.

#### Start-up

The start-up of the concatenated pulse column differs from that of the tall column in that it is necessary to fill the concatenated column from the bottom in order that no large quantities of air will be entrapped in the serpentine contactor circuit. It is impossible to avoid air locks in the light-phase transfer tube when one tries to start an empty concatenated column by filling from the top end. (Although a tall pulse column can be filled from the top, the air in the empty tall column can be displaced more quickly by charging the column from the bottom.)

Significant quantities of air may enter the bottom of the concatenated contactor (for example, when a feed tank accidentally runs dry) once it has been filled, but this air in-flow or in-leakage will be readily passed through the contactor under the influence of the pulse action without seriously interfering with column operation, provided that the column has been designed against the possibility of such air in-leakage. Such provision requires only that the light-phase transfer tubes be of small enough diameter so that the pulsed flow will carry the air through the tubes along with the light phase.

#### Extraction Efficiency

A concatenated pulse column offers not only equal but also apparently somewhat greater extraction efficiency than the equivalent tall pulse column whose contacting length equals the sum of the lengths of the concatenated sections. This is because some additional cocurrent extraction or stripping, resulting from intimate mixing of the two phases produced by turbulence in flowing through the check valve, takes place in the transfer tubes. The mass transfer may occur either in the light-phase transfer tube or the heavy-phase transfer tube; such occurrence depends upon which phase is continuous in the contactor. If, as in Figure 2, the heavy phase is continuous (column interface controlled at the top end of the column), a mixture of both phases will pass through the light-phase tube, but only heavy phase will pass through the heavy-phase tube. However, if the light phase is the continuous phase in the column (column interface controlled at the bottom end of the column), then only light phase will pass through the light-phase tube and a mixture of phases will pass through the heavy-phase tube. The volume of liquid pulsed up and down in any pulse column is *always* greater than the total flow of countercurrently flowing process streams through the column; otherwise, the column would of course flood.

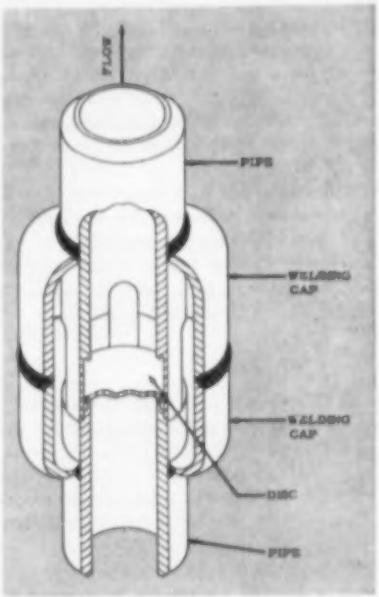



Fig. 3. Typical sectional assembly detail of floating-disc check valve (in closed position).

#### Design and Operating Variables

Important variables investigated in the development of the concatenated pulse column were principally column geometry factors, including ratio of column diameter to transfer tube diameter, geometry of the phase-disengaging zones required at the ends of the contacting sections, design of the check valve, and the number of sections (and, therefore, total contacting length) in the concatenated pulse column. Operating variables included in the investigation were pulse frequency, pulse amplitude, and flow rate. Flapper, ball, and floating-disc check valves were investigated in this development. The range of each variable investigated is shown in Table A (next page).

#### Equipment

The experimental concatenated pulse column model used in this development employed 2-in. diam. Pyrex true-bore

glass pipe for the contacting sections. Each section contained perforated stainless steel plate cartridges dimensionally similar to cartridges most generally used in the tall unisectioned pulse columns. The plate spacings were 2 in., the free-area of the perforated plate was 23%, the perforated hole size was 0.125 in., and the plates were 0.031 in. thick. The pulse generation equipment used for the concatenated column development was the same as that used for previous test work on a tall (*ca.* 30 ft.) 2-in. diam. Pyrex pulse column (that is, a variable-speed, variable-stroke, positive-displacement piston pump minus the pump-head check valves).

Although the first experimental column (shown in Figure 4) consisted of two 4-ft. Pyrex sections, most of the work was carried out in a unit consisting of several 6-ft. sections of 2-in. diam. Pyrex pipe (see Figure 5).

#### CHECK VALVES

Although the first floating-disc check valve proved unsatisfactory because the disc lodged in a tilted position permitting liquid flow in either direction through the transfer tube, several modifications led to an efficient, reliable, floating-disc valve (see Figure 3). The internal pipe section is machined to provide a limited region for movement of the disc so as to prevent the disc's lodging in a tilted position.

The original floating disc valve bodies for the 2-in. diam. glass column were machined out of solid sections of stainless steel. More than 800 hr. (roughly 4 million cycles) of satisfactory valve operation were accumulated in intermittent column operation incorporating the latter type floating-disc valve, and some 3 million cycles were satisfactorily accumulated on two other floating-disc valves of the same design in a continuously cycled valve-test circuit. Subsequent inspection showed no deterioration in effectiveness of the valves (that is, no leakage at beginning or end) and neither valve disc lodged in an inoperative position; hence, the valve design was adopted for use in a radiochemical process pilot plant installation.

In the early experiments commercial swing check valves were employed and yielded reliable service for approximately 1,100 hr. of operation in the original concatenated column assembly, except on two occasions. After several months' contact with solvent, two of the gaskets used in the column to obtain proper glass-to-glass seals deteriorated to the point that large pieces of the gasket were torn off by the pulse action. These pieces became lodged at the pivot of the flapper causing the check valve to remain in the open position. In the final analysis, the use of swing check valves is not considered feasible for long-term plant application because of the possibility of flapper pivot-pin failure, which would render the valve inoperative.

Ball check valves were quickly eliminated primarily because stainless steel ball checks are too heavy causing too great a pressure drop across the column. However, tests made with teflon spheres gave satisfactory operation, but because teflon, among other things, is not stable at high radiation levels, these are not considered suitable for long-term reliable service. Coors ceramic spheres (predominantly $Al_2O_3$), though only briefly tested, proved satisfactory, and it is believed that such would be suitable for the processing of radioactive material.

All the check valves investigated produced an unstable emulsion of the organic-in-aqueous type (organic droplets 200 to 500$\mu$ diam.) as a result of check valve flow turbulence as the streams passed through the valve. It was this intimate mixing which caused the small additional mass transfer to occur in the concatenated column vs. the equivalent tall pulse column.

#### TRANSFER TUBES

The ratio of the diameters of the column and the transfer tubes is important. The light-phase tube must be small enough to assure purging of any air that may enter the lower end of the column. The heavy-phase tube must be large enough to prevent cavitation during the suction pulse. In the development of the concatenated column it was observed that a velocity of at least 1.3 ft./sec. through the light-phase tube was required to sweep significant amounts of air in-leakage through the tube so that the air would escape without causing an air lock in the transfer tube. The best results were obtained experimentally when the ratio of the diameters of the column and the transfer tube was between 4 and 5.

In the 2-in. diam. concatenated column studies, satisfactory operation was obtained with 0.5-in. diam. glass transfer tubes. The average velocity in such tubes was sufficient (80 ft./min. or 1.3 ft./sec.) to assure immediate purge of air entering through the organic feed line at rates up to 30 cu.in./min. Use of stainless steel tubing having an internal diameter of 0.375 in. was also found to be satisfactory for the 2-in. diam. columns. Increasing column-to-tube diameter ratio naturally results in a higher tube velocity, making it easier to purge air, but increases accordingly frictional and acceleration energy losses. Further, the liquid acceleration losses due to the pulse action limits the diameter of the heavy-phase tube to a minimum below which cavitation will occur in the system or at the pulse generator.

#### INTERMEDIATE PHASE-DISENGAGING CHAMBERS

Intermediate phase-disengaging chambers are necessary at the top and bottom of each pulse-column section to facilitate breaking of the organic-in-aqueous emulsion formed by passage through the check valves. An adequate settling period varying somewhat with the physical properties of the solutions (30-60 sec. holdup) permits the two phases to separate; thus emulsion is prevented from being pulsed or recirculated through one or the other transfer tube. The most effective area ratio (chamber to column) was between 2.5 and 4, and the optimum height was about 1 ft.

The phase-disengaging sections of the first experimental concatenated pulse column consisted of 2-in. diam. tees, the same diameter as the column. Operation of the column with the aqueous phase continuous produced an organic-in-aqueous emulsion in the light-phase transfer tube as the liquids passed through the 0.5-in. swing check valves. On the pressure stroke the emulsion failed to break in the small disengaging section (2-in. diam. tees). Hence partial recirculation of the emulsion occurred between adjoining column sections, and this resulted in column flooding. With this end-section geometry, a flooding rate of 620 gal./(sq.ft.)(hr.) was observed with the use of a pulse frequency of 50 cycles/min. and

**Table A.**

| | |
|---|---|
| column-to-tube diameter ratio | 4 to 5.5 |
| column-to-disengaging section diameter ratio | 1 to 3 |
| number of column sections | 2 to 6 |
| total column contacting length | 8 to 36 ft. |
| pulse frequency | 30 to 70 c./min. |
| pulse amplitude | 0.5 to 1.2 in. |
| flow rate (combined flow) | 300 to 1,000 gal./(sq.ft.)(hr.) |

an amplitude of 0.7 in. Next, the 2-in. tees were replaced with settling sections 6 in. diam. and 8 in. high. These enlarged sections provided ample time for phase disengagement. When the above flooding rate test was repeated under the same operating conditions, the flooding rate was observed to be 1,000 gal./sq.ft.(hr.) which represented an increase in flow capacity of about 60%.

In the second model of the concatenated pulse column (Figure 5), the settling chambers on the ends of the sections were made 4 in. diam. and 10 in. high, these dimensions being based on the observation that roughly 30 to 60 sec. was required for the needed phase separation. In addition, enlarged tangential entrances were provided at the mid-circumference of the settling chambers in order to reduce the velocity of the entering stream, since high-velocity radial flow of mixed phases entering the settling sections led to recycle of some of the emulsion between adjoining column sections. This effect prevented efficient phase separation and ultimately led to column flooding. Many factors such as specific gravity, size of droplet, interfacial tension of the system (greatly influenced by impurities), undoubtedly affect the optimum diameter and height of the phase-disengaging chambers; but an investigation of these factors in an orderly manner was not a part of the experimental program. For the particular chemical systems tested by the authors in the concatenated pulse column, it was observed that an area ratio of the settling chamber to the column of between 2.5 and 4, and a chamber height of 1 ft. was required for suitable disengagement. An area ratio of 4 was necessary when the interfacial tension of the systems studied was 10 to 20 dynes/cm. and the specific gravity difference was under 0.15. A ratio of 2.5 was satisfactory when the interfacial tension exceeded 20 dynes/cm. and the gravity difference exceeded 0.15.

**Cavitation**

Cavitation may occur at the pulse generator in a pulse column when the pressure at the pulse generator falls below the vapor pressure of the liquid being pulsed. Vaporization occurs in the form of bubbles which collapse abruptly when the pulse generator in its regular cycle changes from suction-to pressure-pulse action. This momentary vaporization and destructive collapse of the bubbles is cavitation. The shock of bubble collapse can cause pitting of the pulse generator and can create excessive noise and vibration in the system. Cavitation can also occur within the concatenated column during the suction pulse if the heavy-phase transfer tubes are not sufficiently large.

**Pressure Drop**

The total pressure drop in either type of pulse column between the pulser and the top of the column during operation is due to the static head of the liquid system, acceleration and deceleration forces on the liquid, and friction losses. The static head in any pulse column is of course constant throughout the pulse cycle, but the pressure components due to acceleration and friction vary during the cycle. The acceleration pressure varies directly as the sine of the displacement angle (if the displacement angle at the midpoint of the pressure stroke is selected as zero). Therefore, the acceleration pressure is a minimum at 90 degrees (change from pressure to suction stroke) and a maximum at 270 degrees (change from suction to pressure). The magnitude of the acceleration component is the same at either point, differing only in sign to indicate whether the system is putting energy into the pulser or the pulser into the system. The friction component varies as the square of the cosine of the displacement angle.

In the design of the concatenated column, the important factors bearing on the hydraulics of the column include diameter and length of the transfer tubes and the pulse transmission line, design of the check valves, location of the pulse generator, and the pulse frequency and amplitude. Of these the transfer-tube design is the most important since the number of sections which can be designed into a concatenated unit is governed by the pressure drop across these tubes. The most significant pressure component in this respect is that due to fluid acceleration and deceleration in the transfer tubes. As shown in Equation (1) (p. 370), acceleration-deceleration pressure in the pulse column varies as the square of the pulse frequency; the square of the diameters of the column, transfer tubes, transmission line, etc.; directly as the length of the column, tubes, etc.; directly as the pulse amplitude; and directly as the sine of the pulse-cycle displacement angle. The pressure due to friction in the transfer tubes is not a size-determining factor in the design calculations because the friction component of pressure drop varies as the square of the cosine of the pulse cycle displacement angle.

Location of the pulser affects the static head on the unit and the leakage rate past the pulser piston if such a type is used. Locating the pulser at the bottom of the column results in a relatively large static load and increased piston leakage (particularly true for the tall pulse column). However, such a location permits use of higher frequencies without pulser cavitation.

unit operations in nuclear engineering

**SOLVENT EXTRACTION**

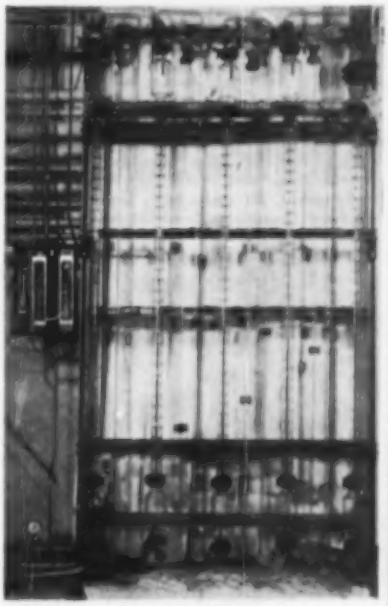
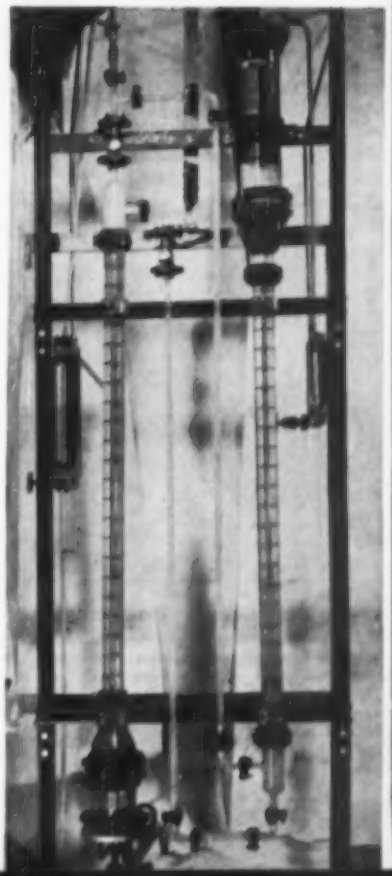


Fig. 5.

Fig. 4.



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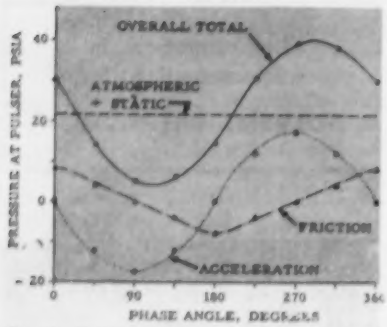


**Fig. 6. Pressure at pulse generator vs. pulse phase angle, concatenated pulse column. Basis: (a) Concatenated pulse column—three 15-ft. long sections; 1 in. diam. transfer tubes; column-to-tube diam. ratio = 4:8. (b) Pulse conditions—frequency, 50 cycles/min.; amplitude, 1 in. (c) Pulse transmission lines—25 ft. long; 2.5 in. diam.**

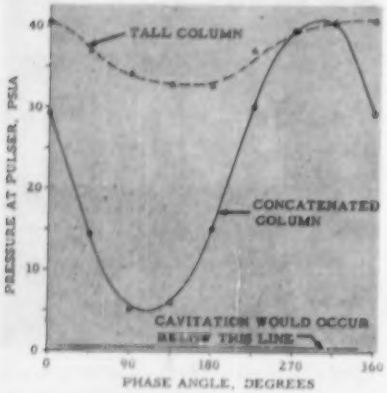


**Fig. 7. Pressure at pulse generator vs. pulse phase angle, concatenated vs. tall pulse column. Basis: (a) Concatenated pulse column—three 15-ft. long sections; 1 in. diam. transfer tubes; column-to-tube diam. ratio = 4:8. (b) Tall pulse column—45 ft. high. (c) Pulse conditions—frequency, 50 cycles/min.; amplitude, 1 in. (d) Pulse transmission line—25 ft. long; 2.5 in. diam.**

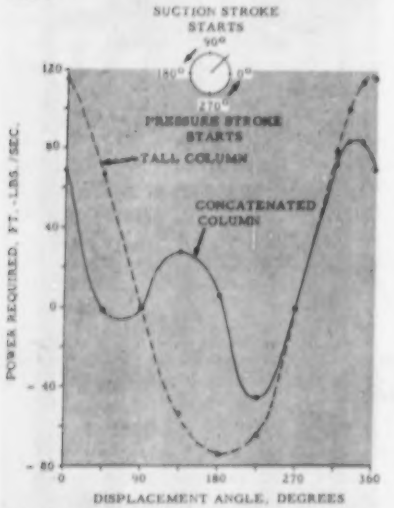


**Fig. 8. Instantaneous power vs. pulse cycle, concatenated vs. tall pulse column. Basis: (a) Concatenated pulse column—three 15-ft. sections. (b) Tall pulse column—45 ft. high. (c) Pulse conditions—frequency, 50 cycles/min.; amplitude, 1 in.**

## CALCULATION OF PRESSURE DROP (2) CONCATENATED COLUMN

Figure 6, a plot of pressure drop components vs. pulse-cycle displacement angle, illustrates the fact that the acceleration pressure is the dominant component for design purposes. For the concatenated column, the pressure due to acceleration may be calculated from the approximate Equation (1).

$$\Delta P_A = \frac{\rho_{avg.} h}{g_c}\left[ L_1 + L_2\frac{S_1}{S_2} + L_3\frac{S_1}{S_3}\right] [-(2\pi f)^2 \sin\theta] \qquad (1)$$

where

$\Delta P_A$* = pressure drop due to acceleration of liquid system between pulser and top of column.

$\rho_{avg.}$ = density of the liquid system, lb./cu.ft.

$h$ = amplitude of cyclic motion in column: one half of total displacement distance in column, ft. Note: "pulse amplitude" = $2h$).

$g_c$ = conversion factor, lb. mass-ft./(lb. force)(sec.)(sec.).

$L_1$ = effective height of column, ft.

$L_2$ = length of pulse transmission line, ft.

$L_3$ = total length of each series of transfer tubes, ft.

$S_1$ = cross-sectional area of the column, sq.in.

$S_2$ = cross-sectional area of pulse transmission line, sq.in.

$S_3$ = cross-sectional area of transfer tube, sq.in.

$f$ = pulse frequency, cycles/sec.

$\theta = 2\pi$ ft. = displacement angle, degrees.

$t$ = time, sec.

The terms in the second bracket represent the second derivative of the equation for cyclic motion, $y = h \sin\theta$. (Simple harmonic motion was assumed for the purposes of this paper.) $\theta = 0$ degrees is the midpoint of the pressure stroke.

For the comparable situation in the tall pulse column the equation is the same except that the third term of the first bracket is naturally omitted since this term is the transfer tube component.

## CALCULATION OF PRESSURE DROP TALL PULSE COLUMN

Letting $k = \frac{\rho_{avg.} h}{g_c}(2\pi f)^2$,

then the acceleration pressure components are

$L_1 \quad k \sin\theta$ = acceleration pressure in column.

$L_2 \frac{S_1}{S_2} k \sin\theta$ = acceleration pressure in transmission line.

$L_3 \frac{S_1}{S_3} k \sin\theta$ = acceleration pressure in transfer tube.

For a 5-in. diam. concatenated column of three sections each 15 ft. long,

$$\Delta P_A = -\frac{70}{32.17}\left(\frac{1}{24}\right)\frac{1}{144}\left[45 + 25\left(\frac{25.3}{6.1}\right) + 36\left(\frac{25.3}{1.1}\right)\right]\left(2\pi\frac{50}{60}\right)^2 \sin\theta$$

where

$\rho_{avg.}$ = 70 lb./sq.ft.
$h$ = 1/24 ft.
$L_1$ = 45 ft.
$L_2$ = 25 ft.
$L_3$ = 36 ft.
$S_1$ = 25.1 sq.in.
$S_2$ = 6.1 sq.in.
$S_3$ = 1.1 sq.in.
$f$ = 50 c./min.
= $-17.11 \sin\theta$ lb./sq.in. = $\pm 17.11$ lb./sq.in. *max.*

By examination, it is seen that the acceleration pressure drop in the transfer tubes accounts for 85% of this pressure: namely, 14.5 sin $\theta$. Figure 7 illustrates approximately the difference between the total pressure drop in a concatenated column (three sections totaling 45-ft. length) vs. a comparable tall pulse column (45-ft. height).

### Power Requirements

The power required to pulse a concatenated pulse column is usually less than the power required for a tall pulse column. The power required for any pulse column is determined by the static head of the liquid system, the acceleration and deceleration forces on the liquid system, and friction losses (*2*). The power required reaches a maximum during the pressure stroke (see Figure 8). Most of the input is required to overcome the static load; hence, the power input required to pulse a tall column is usually greater than for a concatenated column of equivalent contacting length.

### Literature Cited

1. Irvine, A. R., Private Communication, Oak Ridge National Laboratory (July, 1956).
2. Jealous, A. C., and H. F. Johnson, *Ind. Eng. Chem.*, **47**, No. 6, 1159-1166 (June, 1955).
3. Sege, G., and F. W. Woodfield, *Chem. Eng. Progr.*, **50**, No. 8, 396 (August, 1954).
4. Stockdale, W. G., *Chem. Eng.* (April, 1956).
5. Van Dijck, W. J. D., U. S. Patent 2,011,186 (August 13, 1935).

*Presented at A.I.Ch.E. meeting, Pittsburgh, Pennsylvania.*

* Observed and calculated pressure drops agreed closely even though such things as "equivalent lengths" for check valves (which have not been measured) were not included in the calculation.

Batch vs. continuous methods of operation of a nuclear reactor for producing the lowest power costs are compared for the purpose of developing a general criterion for the economic selection of the type of process to be used.

# BATCH VERSUS CONTINUOUS PROCESSING

## *Removal of "poisons" and "ashes" in nuclear homogeneous reactor fuels*

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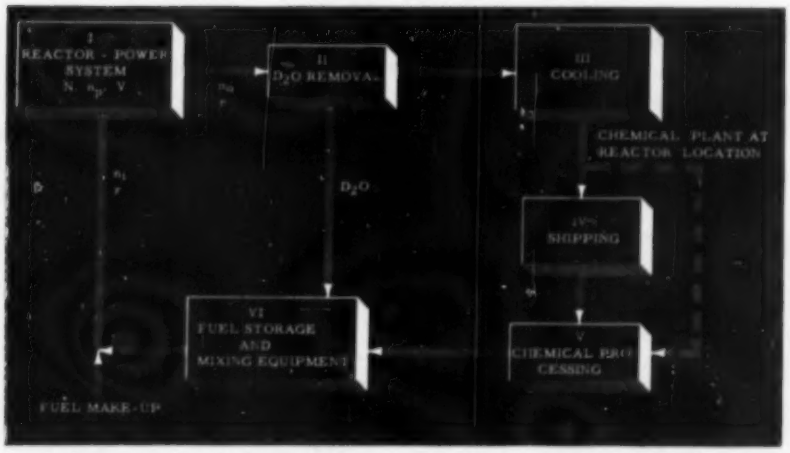



Fig. 1. Process flow sheet for homogeneous reactor fuel cycle. Note: for *batch processing*, equipment in steps II, III, and VI is larger than the equipment required for *continuous processing*.

**Table 1.—Relative Inventory Requirements**

| Processing inventory | Total system inventory | | Batch inventory |
|---|---|---|---|
| reactor-power system inventory | reactor-power system inventory | | continuous inventory |
| | continuous process | batch process | |
| 1 | 2 | 3 | 1.5 |
| 0.5 | 1.5 | 2.5 | 1.67 |
| 0.25 | 1.25 | 2.25 | 1.78 |
| $f$ | $(1+f) = s$ | $2+f$ | $\left(\frac{2+f}{1+f}\right) = Z$ |

The homogeneous power reactor of the converter or breeder type has been described in recent literature (*1*). It uses fissionable and fertile fuel components as liquid or slurry mixtures, generates heat, and accumulates fission products in solution or slurry form. These fission products, often called nuclear "ashes" or "poisons," absorb neutrons quite readily and tend to quench the nuclear reaction. The loss of neutrons to nonfissionable processes within the reactor is costly. On the other hand, removal of the poisons by radiochemical processing procedures is also costly. Hence, there is an economic balance between poisoning and processing costs. Ferguson (*2*) has made an economic analysis of the homogeneous fuel-processing problem using continuous processing only.

### Definition of Systems Studied

The basic fuel cycle for the homogeneous reactor is pictured in Figure 1. The reactor-power system (*1*) consists of either the single-region solution or slurry-type reactor with the required heat-exchange equipment to produce power. Another alternate system would be the core of the two-region homogeneous breeder with its requisite heat-exchange equipment. Two alternatives for processing the liquid fuel to remove poisons are discussed in the next section.

C. E. Dryden was on leave from The Ohio State University.

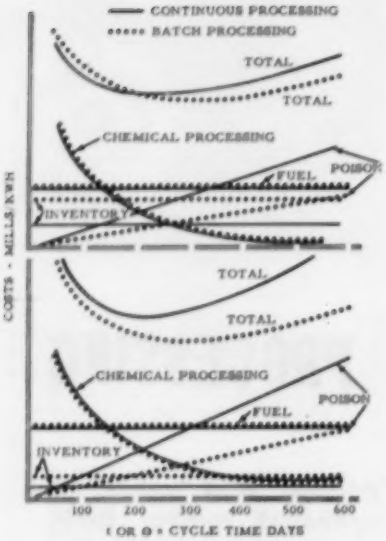



Fig. 2. Typical fuel cycle costs.

#### BATCH PROCESSING

The reactor is charged with a critical solution volume and operated for a given economic time cycle. Sufficient enriched fuel is added to supply fuel requirements and keep the reactor critical. At the end of the cycle, the $D_2O$ is immediately removed in an evaporator (II) and mixed with decontaminated fuel in a dissolver or homogenizer (VI) and recharged to the reactor to start the next power cycle. The equipment should be so designed that this entire recharging job is accomplished in a day or less. With economic power cycles of the order of 200 days, this represents a loss in availability of 0.5% or less. It should be pointed out that this type of processing presupposes a tie-in with an electrical system having more than one source of supply, either as additional homogeneous nuclear reactors or as other typical power plants. The spent residual fuel is cooled to a suitable decay energy (III) and shipped (IV) and/or processed in a continuous cycle in a radiochemical plant (V) to remove fission poisons and recover fissionable fuel. The latter is returned to storage (VI) for the next cycle.

#### CONTINUOUS PROCESSING

The reactor is charged with a critical solution volume and continuously operated at the required power level until shut down for repairs. The fuel solution is removed continuously from the reactor at a predetermined economic rate and the remainder of the fuel cycle is operated on a continuous basis in relatively small equipment.

The high-priced fuel-$D_2O$ inventory requirements for the two processes must be compared since this is one of the economic factors on which to judge the two types of processing. Inventories relative to the reactor-power system can be predicated on an assumption that the major holdup is in the cooling step. Thus, for a truly continuous process with a no-mixing condition in the cooling system, the ratio of processing inventory to the reactor-system inventory is approximately equal to the ratio of cooling time to reactor cycle time. This ratio is called $f$ (see Table 1). Then the ratio of total inventory to the reactor-power inventory is $1+f$. The inventory for a batch-operated cycle requires an additional unit of reactor-power system inventory if the chemical processing plant is to run continuously. The total inventory to reactor-power inventory ratio is $2+f$ for the batch case. If there were no cooling requirement, a minimum of two reactor-power system units would be required: a *clean unit* which is added to the reactor just after the *irradiated unit* is removed. Table 1 lists typical values for these relationships.

An economic analysis of the two processes will be made to study the effect of rate of poison build-up, inventory, chemical processing costs, and fuel burn-up costs on the reactor-power costs expressed as mills/kw.-hr. It is assumed that the difference in equipment costs for the two processes is a negligible factor.

## DERIVATION OF ECONOMIC EQUATIONS

#### Batch Processing

The rate of poison build-up on the assumption of stable, nonvolatile poisons is

$$\frac{dN_p}{dt} = aN_f\sigma_f\phi \tag{1}$$

If $a$, $\sigma_f$, $\phi$ and $N_f$ are kept constant with time and $N_p = 0$ when $t = 0$; then

$$N_p = aN_f\sigma_f\phi t \tag{2}$$

The rate of neutron loss to poisons is

$$-\frac{dY}{dt} = N_p\sigma_p\phi \tag{3}$$

Substitution of (2) in (3):

$$-\frac{dY}{dt} = aN_f\sigma_f\phi^2\sigma_p t \tag{4}$$

On the assumption that each neutron lost to poison is a loss of fission fuel in the presence of fertile fuel, then the cost rate due to poisoning is

$$\frac{dC_p}{dt} = \frac{aN_f\sigma_f\phi^2\sigma_p M_f v_f}{A}\, t \tag{5}$$

Integration of (5) gives

$$C_p = \frac{aN_f\sigma_f\phi^2\sigma_p M_f v_f}{2A}\, t^2 \tag{6}$$

The cost of chemical reprocessing at the end of the batch cycle can be divided into two parts:

1. For process losses:

$$C_L = \frac{N_f M_f L v}{A} \tag{7}$$

2. For processing costs:

$$C_c = \frac{N_f M_f c_c}{A} \tag{8}$$

The cost of burning fuel in the reactor with a conversion ratio of $x$ is

$$C_f = \frac{M_f N_f \sigma_f \phi t v_f (1-x)}{A} \tag{9}$$

The cost of inventory for the batch process, relative to the continuous process, is

$$C_i = \frac{sZN_f M_f v I}{A}\left(\frac{t}{365\times 3600\times 24}\right) \tag{10}$$

The total cost of the batch operation in dollars is

$$C_t = C_p + C_L + C_c + C_f + C_i \tag{11}$$

To put the costs in mills/kw.-hr., the total energy produced in time $t$ is

$$E = ebN_f\sigma_f\phi t \tag{12}$$

The cost in mills/kw.-hr. is thus:

$$\frac{C_t 10^3}{E} = c_t \tag{13}$$

Substitution of Equations (6)-(12) in (13) gives

$$c_t = \frac{M_f 10^3}{Aeb}\left[\left(\frac{av_f\phi\sigma_p t}{2} + \frac{Lv + c_c}{\phi\sigma_f t}\right) + v_f(1-x) + \frac{sZvI}{3.16\times 10^7\phi\sigma_f}\right] \tag{14}$$

The time for minimum total cost can be found by differentiating (14) with respect to $t$.

$$\frac{dc_t}{dt} = \frac{av_f\phi\sigma_p}{2} - \frac{Lv + c_c}{\phi\sigma_f t^2_{min}} = 0 \tag{15}$$

or:

$$t_{min} = \frac{\sqrt{2}}{\phi}\left(\frac{Lv + c_c}{av_f\sigma_p\sigma_f}\right)^{1/2} \tag{16}$$

These equations are based on the time required to process the core volume only. It can be shown that the cycle time is directly proportional to the reactor-power system volume and inversely proportional to the reactor flux.

#### Continuous Processing

Reference is made to Figure 1 in setting up the rate equations for poisons. As before, these equations are based on the time required to process the core volume only.

Accumulation rate = generation rate + input − output or

$$V\frac{dn_p}{dt} = V(an_f\sigma_f\phi) + n_i r - n_o r \quad (17)$$

By definition, the pumping rate,

$$r = \frac{V}{\theta} \quad (18)$$

Note also that $n_i = 0$, $n_o = n_p$, and $N = Vn$, then Equation (17) becomes

$$\frac{dN_p}{dt} = aN_f\sigma_f\phi - \frac{N_p}{\theta} \quad (19)$$

The solution of this differential equation results in:

$$N_p = aN_f\sigma_f\phi\theta(1 - e^{-t/\theta}) \quad (20)$$

For the steady-state value, $t = \infty$ and

$$N_p = aN_f\sigma_f\phi\theta \quad (21)$$

The absorption of neutrons in the poison is thus as follows:

$$N_p\sigma_p\phi = aN_f\sigma_f\sigma_p\phi^2\theta \quad (22)$$

On the assumption that each neutron lost to poison is a loss of fuel, the cost rate due to poisoning is a constant and equal to

$$\frac{dC'_p}{dt} = \frac{aN_f\sigma_f\sigma_p\phi^2 M_f v_f}{A}\theta \quad (23)$$

The electrical power from the reactor core is

$$P = ebN_f\sigma_f\phi \quad (24)$$

The poisoning costs in mills/kw.-hr. becomes

$$c'_p = \frac{M_f 10^3}{Aeb}(av_f\phi\sigma_p\theta) \quad (25)$$

It is seen that the poisoning cost for continuous processing is twice that for batch processing because the average poison level in the batch system is always one half of the poison level in a continuous system for the same cycle period.

By the same method used in the batch process to derive the costs of processing fuel, and inventory [See Equations (7)-(12)], but substituting $\theta$ for $t$ and $Z = 1$, the total cost for continuous processing is:

$$c'_t = \frac{M_f 10^3}{Aeb}\left[\left(av_f\phi\sigma_p\theta + \frac{Lv + c_o}{\phi\sigma_f\theta}\right) + v_f(1 - x) + \frac{svI}{3.16 \times 10^7\phi\sigma_f}\right] \quad (26)$$

The time for minimum total cost in the continuous process can be found by differentiating (26) with respect to $\theta$.

$$\theta_{min} = \frac{1}{\phi}\left(\frac{Lv + c_o}{av_f\sigma_p\sigma_f}\right)^{1/2} \quad (27)$$

By inspection of (16) and (27) one sees that

$$t_{min} = \sqrt{2}\,\theta_{min} \quad (28)$$

(Note that in either case, the cycle time is inversely proportional to the reactor flux.)

In the derivation of these equations it was assumed that fissionable fuel concentration did not change with time. In actual operation the reactor would be controlled by increasing the fission fuel concentration with poison build-up in a nonlinear fashion. However, the neglect of this factor will not change the basic conclusions of this analysis.

---

#### Economic Comparison of Batch and Continuous Processing

The equations developed in the previous section can be used to determine the total costs of the fuel-handling cycle for batch and continuous processing. Two typical cases are schematically represented in Figure 2. Specific costs are not calculated for security reasons. In Figure 2, Case 1, the over-all costs are similar with the batch cycle time larger by the $\sqrt{2}$ factor. This near equality of costs results from high-inventory charges. In Figure 2, Case 2, low-inventory costs, coupled with a high reactor neutron flux level, give a definite cost advantage to batch operation.

With reference to the development of a general criterion for selection of batch or continuous processing: this can be done by mathematical manipulation of the total cost Equations (14) and (26). Equate these at the respective minimum cost point for each process and express $\theta_{min}$ in terms of $t_{min}$ by Equation (28). The terms are rearranged to give costs as follows:

Inventory costs (batch-continuous) = poisoning + processing costs (continuous-batch)

Substitution of the mathematical terms for the above gives

$$\frac{svI}{3.16 \times 10^7\phi\sigma_f}(Z_a - 1) = (\sqrt{2} - 1)$$

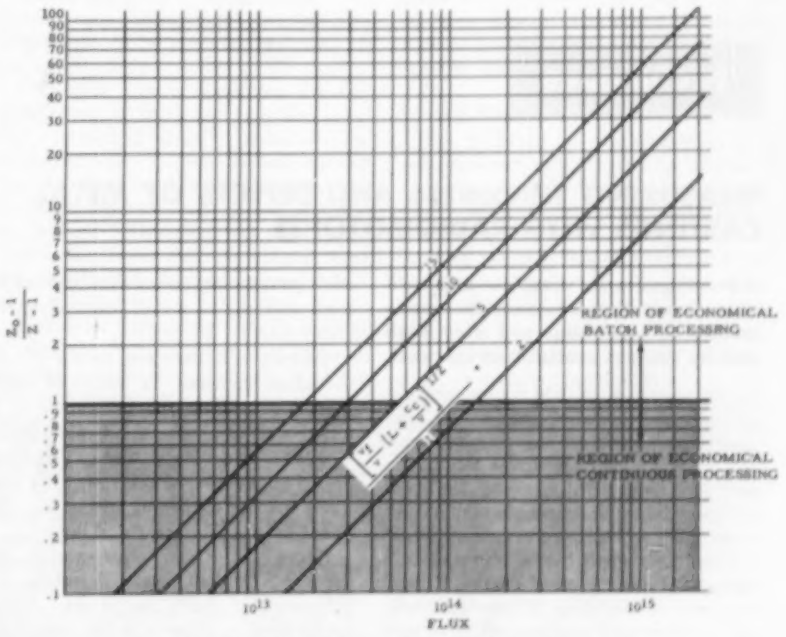



Fig. 3. Graphical solution to determine choice of process.

$$\left[ a\nu_f\phi\sigma_p \frac{t_{min}}{2} + \frac{Lv + c_c}{\phi\sigma_f t_{min}} \right] \qquad (29)$$

where

$Z_o$ is the value of $Z$ required for batch costs to equal continuous costs. From Table 1, $s = 1/Z - 1$, and with the substitution of Equation (16) in (29), it follows

$$\frac{Z_o - 1}{Z - 1} = 1.85 \times 10^7 \phi (a\sigma_p\sigma_f)^{1/2} \left[ \frac{v_f}{v} \left( L + \frac{c_c}{v} \right) \right]^{1/2} \frac{}{I} \qquad (30)$$

A plot derived from Equation (30) of $(Z_o - 1)/(Z - 1)$ vs. $\phi$ with the fuel cost factor as a parameter, is given in Figure 3. The physics data were chosen as: $a = 1.8$, $\sigma_p = 40$ barns/fission atom, $\sigma_f = 549$ barns. For any given system, a value of $(Z - 1)$ can be found from Table 1. If the actual value of $(Z - 1)$ is less than $(Z_o - 1)$, i.e., $(Z_o - 1)/(Z - 1) > 1$, then from Equation (29), it is seen that

Inventory costs (batch-continuous) < poisoning + processing costs (continuous-batch).

Hence, there is an economic incentive to use batch processing for this case. If $(Z_o - 1)/(Z - 1) < 1$, the converse is true and continuous processing is recommended. Figure 3 shows that high flux, low-inventory charges, high fuel and chemical reprocessing costs favor the batch-processing method.

**Notation**

- $a$ = yield of poison atoms/fission
- $A$ = Avogadro's number = $6.023 \times 10^{23}$
- $b$ = heat energy produced/fission, kw.-hr./fission = $8.23 \times 10^{-18}$
- $c_c$ = cost of chemical processing, $/g. fissionable fuel
- $c_p$ = cost of poisoning, mills/kw.-hr.
- $c_t$ = total cost of poisoning, processing, fuel and inventory, mills/kw.-hr.
- $C_c$ = chemical processing cost/cycle, $
- $C_f$ = fuel costs/cycle, $
- $C_i$ = inventory costs/cycle, $
- $C_L$ = fuel loss in processing/cycle, $
- $C_p$ = poison costs/cycle, $
- $C_t$ = total costs of poisoning, processing, fuel and inventory/cycle, $
- $e$ = thermal efficiency of reactor and turbine
- $E$ = total kw.-hr. produced/cycle
- $f$ = ratio of processing inventory to reactor-power system inventory
- $I$ = inventory charge, annual $ of fuel value
- $L$ = fraction of fuel lost during processing
- $M_f$ = atomic weight of fuel
- $n$ = concentration in reactor core volume, atoms/cc.
- $n_f$ = concentration of fissionable material in reactor, atoms/cc.
- $n_i$ = concentration of poisons in inlet fuel stream, atoms/cc.
- $n_o$ = concentration of poisons in outlet fuel stream, atoms/cc.
- $n_p$ = concentration of poisons in the reactor, atoms/cc.
- $N$ = total atoms in reactor
- $N_f$ = total atoms of fuel/core volume
- $N_p$ = total atoms of poisons/core volume
- $P$ = reactor power level, kw.-hr./sec.
- $r$ = rate of removal of solution in cc./sec.
- $s$ = ratio of total fuel inventory in continuous processing reactor system to that in reactor core and circulating heat-exchange system (reactor-power system)
- $t$ = elapsed time, sec.
- $v$ = value of fissionable fuel in reactor system, $/g.
- $v_f$ = value of fissionable fuel added as feed, $/g.
- $V$ = reactor core volume, cc.
- $x$ = conversion ratio for a clean, unpoisoned reactor, fuel produced/fuel burned
- $Y$ = neutron density level in core
- $Z$ = ratio of fuel inventory in batch process to that in a continuous process
- $Z_o$ = value of Z required to make costs of batch and continuous methods equal
- $\phi$ = reactor flux, neutrons/(sq.cm.)(sec.)
- $\sigma_f$ = fission cross-section, sq.cm./atom
- $\sigma_p$ = absorption cross-section for poisons, sq.cm./fission atom
- $\theta$ = time to process one core volume on a continuous basis, sec.
- ' refers to continuous processing

**Literature Cited**


1. Beall, S. E., and C. E. Winters, *Chem. Eng. Progr.*, **50**, 256 (1954).
2. Ferguson, D. E., Section C-1, Proceedings of Nuclear Engineering Conference, Berkeley, California (1953).


**techniques**

## MEASURING THICKNESS AND DEFECTS OF METAL CASTINGS WITH RADIOISOTOPES

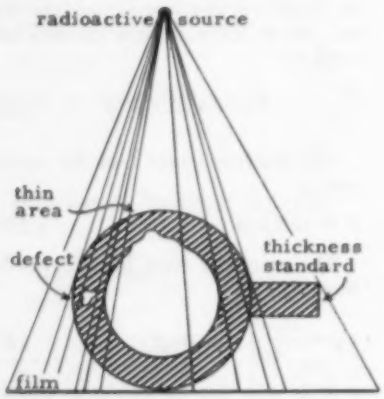
**Advantages are: versatile and reliable inspection; inspection made without dismantling; and very high activity sources available at low cost.**

In the operation of field equipment subject to rapid corrosion such as heat exchangers, pipelines and pressure vessels, a knowledge of probable service life and the ability to measure the wall thickness of critical areas are important in warning of incipient failures.

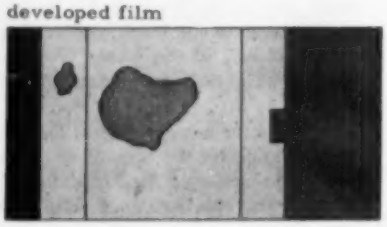
Cobalt 60 (half-life 5.3 years; beta energy 0.3 mev; gamma energy 1.1 and 1.3 mev) is replacing X-rays and radium in many such applications. Per unit activity, Co-60 has approximately 50% more penetrating power than radium for thick sections of metal. Cost is appreciably less.

Technique is the same as for X-rays or radium capsules. A source of radiation is placed above the section to be tested and a photographic film below. The latter is developed and can be interpreted qualitatively in terms of the relatively greater darkening of the film produced by the thin areas and defects.

In the case of a pipe, for example, the method is said to permit detection of a difference of 1.5% or of 0.01 inches (whichever is larger) in the sum of the wall thicknesses.




developed film



# EVALUATION OF PROCESS VARIABLES in the recovery of spent reactor fuel

The application of the mathematical theory of the "analysis of variance" to general problems in plant material balance calculation is discussed here. Also given is the derivation of a graphic plot which includes an empirical operating line indicating the safe number of batches which can be charged to a spent enriched uranium reactor fuel dissolver.

*Frank P. Vance and Fred H. Tingey* | Phillips Petroleum Company, Idaho Falls, Idaho

Use of material balance for process control is fundamental and vital throughout the chemical industry. However, at the Idaho Chemical Processing Plant (I.C.P.P.), where spent nuclear reactor fuel elements are processed to recover their uranium content, concentration measurement and control must be given an uncommon emphasis. The reasons for this emphasis are twofold:

1. *High value of the uranium.* Not only must process losses be kept at a minimum, but those losses which do occur must be accounted for with high precision to conform to A.E.C. requirements.

2. *Hazard of nuclear criticality.* Concentrations of fissionable material must be rigidly controlled, and any degree of uncertainty should be mitigated by modification of throughputs so that the probability of a nuclear explosion is negligible.

The chief process operations are (1) dissolution in nitric acid of the spent fuel elements ("slugs") which are delivered to I.C.P.P. from various reactor sites followed by (2) separation of the dissolved uranium from fission products by solvent extraction. Concentration measurements on the operating process are complicated by several special factors, including:

1. *Remote sampling.* Radioactivity level of the slugs, the dissolver solution, and the uranium-lean raffinate is of the order of many curies per cubic centimeter.

2. *Nonuniformity of feed material.* The slug fabricators must assign average U contents, as no precise method is in use for measuring these contents after fabrication. Also, the uranium concentrations in specific spent slugs cannot be assigned accurately by the reactor operators; this reflects their inability to estimate accurately the energy dissipated in a specific area of the reactor. In addition to these special factors, the usual routine sources of error, such as sample preparation, skill of individual analyst, time of analysis, are also present.

Satisfaction of the rigid concentration requirements in the face of the enumerated difficulties implies elaborate quality control programs and equally costly investigations of apparent discrepancies. Clearly, the establishment of realistic limits of uncertainty for each of the concentration measurements in the process will reflect savings in manpower as well as optimization of plant capacity.

Such a set of limits may be rigorously determined by application of a statistical method to a set of material balance data, provided these data are taken with a procedure tailored to accommodate the method. The procedure and the mathematical basis for the method are developed in the following section.

### General Statistical Approach

The precision or reproducibility of a measurement method can be estimated (on the basis of certain assumptions) by a statistic computed from a series of determinations (replicates). It is to be assumed that the replicates are taken when the errors of measurement are random, and the method is therefore said to be "in control." This statistic, called the *sample* variance of a measurement, is usually denoted by $s^2$ as contrasted with $\sigma^2$ for the corresponding *population* value. It is the mean-square deviation of the determinations from their own mean and is computed by the convenient formula,

$$s^2 = \frac{\sum_{i=1}^{n} x_i^2 - \frac{\left[\sum_{i=1}^{n} x_i\right]^2}{n}}{n-1}$$

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where

$x_i$ represents the i'th determination

$n$ is the number of determinations. [The use of $n-1$ instead of $n$ in the denominator is a refinement resulting from certain theoretical considerations (*1*).]

The square root of the "sample variance" is known as the "sample standard deviation," usually denoted $s$. Under fairly reasonable assumptions on the distribution of errors of measurement, the theory of probability provides multiplicative factors for $s$, commonly called "$t$-factors," dependent upon the number of observations $n$, and the degree of confidence one desires to assign to the inference that the random interval (mean of the observations $-ts/\sqrt{n}$, mean of the observations $+ ts/\sqrt{n}$) contains the true level of the component being measured. In the event that a confidence interval is to be constructed from a single observation, as is usually the case in routine chemical laboratory application, the interval is of the form (observation $- ts$, observation $+ ts$) where $t$ is chosen to correspond to the desired confidence level and the number of determinations ($n$) from which $s$ was computed. Values of $t$ for various sample sizes and confidence levels are available in any standard statistical text (*1, 4, 5*). It is apparent that for $n$ greater than 10 the $t$ value which results in a 95% confidence interval for the true level of the component measured is approximately 2. For comparison 99% confidence interval multipliers are listed in Table A.

Unfortunately the end result reported by the laboratory in most chemical process studies involves not only the measurement (or analytical) error due to the particular method of analysis used but is a composite reflection of many sources of variation, for example, sampling, sample preparation, analyst, time of analysis. Often many of these can logically be assumed to be of such insignificant magnitude that they can be justifiably ignored.

In the case of remote sampling of a highly radioactive uranyl nitrate solution, such as is done at I.C.P.P., the existence of extraordinary sources of variation constitutes a serious problem. A refinement of the simple variance estimating procedure as given above is therefore necessary to effect a separation of the total variation into component parts attributable to the appropriate sources. Such a technique is contained in the mathematical theory of analysis of variance. It is prerequisite to such an analysis, however, that the observations be obtained according to a predesigned scheme, determined by basic assumptions as to the manner in which the deviations under consideration combine to give the final observation.

**Table A.**

| $n$ | $t^{95}$ | $t^{99}$ |
|---|---|---|
| 2 | 12.71 | 63.66 |
| 10 | 2.26 | 3.25 |
| 100 | 1.99 | 2.63 |
| ∞ | 1.96 | 2.58 |

### Preliminary Considerations

Preliminary to a program to identify and estimate significance of component precisions in plant material balance calculations, each possible source of variation was subjected to critical scrutiny for purposes of standardization and refinement of method and techniques.

It was evident that certain weaknesses existed in the I.C.P.P. quality control program which were producing inaccurate estimates of the precision to be associated with a given technique. This was due primarily to the fact that a *synthetic sample quality control program alone cannot adequately and effectively yield realistic uncertainty limits* where there is reason to believe that sampling and sample preparation error are of a significant magnitude. This is likely the rule rather than the exception in any chemical processing plant.

At I.C.P.P. the size of a uranium metal charge to a batch dissolver is limited by nuclear mass considerations; for the particular dissolver size, geometry, and regime there is an upper safe limit on the quantity of fissionable uranium which can be contained, beyond which a critical mass may be accumulated. The completeness of dissolution varies for each batch depending on the metallurgical and irradiation history of the reactor fuel being dissolved. This results in a varying amount of metal left behind (heel) in the dissolver after each dissolution. The accumulation of metal, in turn, has a significant effect on dissolution and this complicates the determination of successive heels. The residual heel in the dissolver plus a new charge must never exceed the upper safe uranium mass limit. Each heel is determined by the difference in uranium content of the metal charge and the dissolver solution after dissolution. The content of the metal charge is based entirely upon an estimate prepared by the operator of the reactor and is subject to large error because of uncertainties in the average burnout based on reactor flux, flux distribution, and where the metal was positioned in the reactor. The content of the dissolver solution is based on plant analytical methods and solution volume and density measurements. It is apparent that any systematic error in either of these measurements will be cumulative in heel determination following successive dissolutions and could lead to disastrous consequences. Therefore, a comprehensive evaluation of the uncertainties affecting the heel estimate was in order.

The investigation of input measurements began with the plant run-tanks. In view of the anticipated sampling error associated with an increment of dissolver solution, a series of homogeneity tests was conducted in order to determine the minimum time necessary to bring a relatively heterogeneous uranyl nitrate-nitric acid-aluminum nitrate-fission product-water system to uniform composition throughout. An analysis of the data collected under this program indicated that 45 min. was sufficient essentially to bring sampling error to an irreducible minimum as judged by the analytical method upon which plant input is based—isotopic dilution. This accordingly became standard operating procedure. In addition, it was deemed wise to specify a minimum of 10 min. of purging of the sample draw line between collections in order to insure that samples were truly independent.

An integrated quality control program was formulated with the following objectives in view:

1. to facilitate a resolution of the total variation into its relevant components; hence to enable the Quality Control supervisor to trouble-shoot vulnerable steps in the over-all measurement;
2. realistic estimates of the precision for uranium accountability purposes and also for defining an operating line for dissolver charging;
3. the direction in which to proceed to effect reductions in analytical effort without seriously impairing the over-all precision;
4. data to be collected in a manner to allow evaluation of the effects of the important operating variables and other parameters of the system.
5. the possibility of estimating the bias and precision to be associated with each analytical method and each process sample with a substantial reduction in the number of analyses (15% of the laboratory total effort) then being performed solely for the purpose of quality control.
6. any shift in the bias and precision of a technique as applied to a given process sample to be immediately detected and steps taken to effect resolution.

With these objectives, the program was effected in two parts: (1) a series of designed experiments with the use of *process samples* to accomplish the objective with regard to precision, and (2) a vastly reduced and simplified synthetic control program augmented by bench-standard checks and regression analysis for bias estimation. In particular the sampling scheme used on all process solutions measured tankwise, batchwise, or sample bottlewise, is known as the nested, hierarchical, or multistage grouping type (*1*). For example, the precision of an isotopic dilution analysis of a given run-tank batch is influenced by many sources of error; primarily the homogeneity of the solution is reflected by the degree to which the sample represents (or fails to represent) the batch concentration; the sample preparation step which involves re-

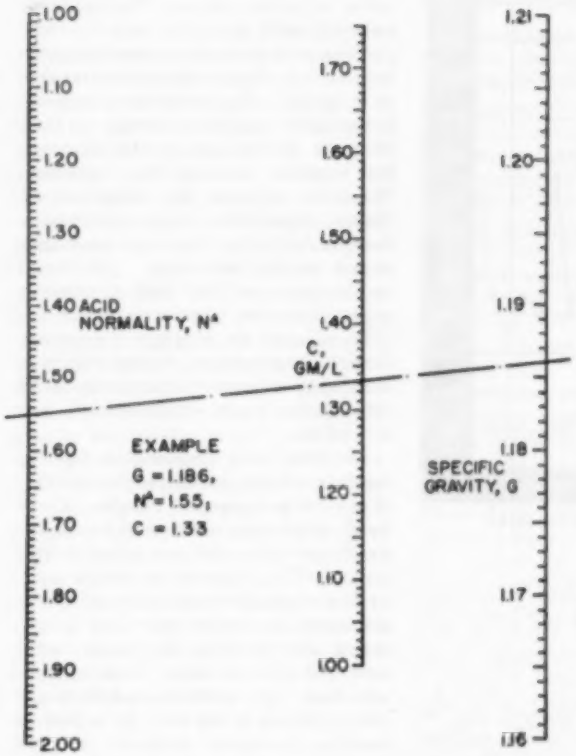
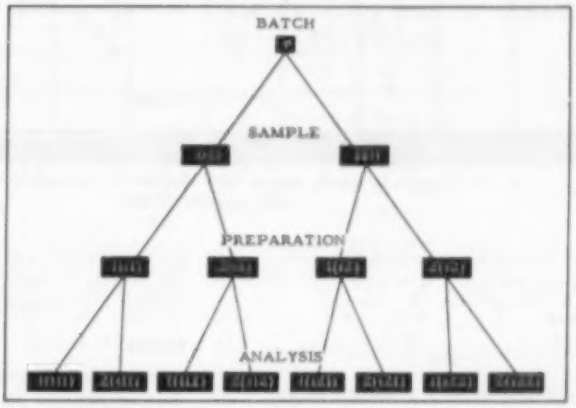



Fig. 1. Alignment chart for the equation $C = 10.93(G - 1.021) - .304N^A$.

Fig. A. Schematic representation of method of estimating variance components at I.C.P.P.




mote pipetting of 500 microliters of the sample solution, the spiking of this sample with a measured volume of $U^{233}$, and the subsequent decontamination of the spiked solution; and the reproducibility of the mass spectrometer by which the isotopic distribution is measured, from which the sample concentration is finally computed.

A mathematical model relating these components to the observed values is

$$x_{ijkm} = \mu + \alpha_i + \beta_{j(i)} + \gamma_{k(ij)} + \delta_{m(ijk)} \quad (1)$$

where

- $x_{ijkm}$ denotes the m'th analysis on the k'th preparation of the j'th sample drawn from the i'th batch
- $\mu$ denotes the "true" average batch concentration
- $\alpha_i$ denotes that part of the deviation of $x_{ijkm}$ from the over-all mean, attributable to the particular batch sampled
- $\beta_{j(i)}$ denotes the deviation peculiar to the j'th sample drawn from the i'th batch
- $\gamma_{k(ij)}$ denotes the deviation attributable to the k'th preparation of the j'th sample from the i'th batch
- $\delta_{m(ijk)}$ denotes that part of the total deviation due solely to analytical error, that is, reproducibility of the mass spectrometer

In the general case no restriction need be placed on the number of groups of the first-order corresponding to subscript $i$, the number of second-order groups corresponding to subscript $j$, the number of third-order groups corresponding to subscript $k$, nor the number of fourth-order groups carrying subscript $m$. Furthermore, the number in any given subgroup need not be the same for all groups. The flexibility of this sampling plan and the ease of the analysis make it ideal for surveillance of chemical plant material balance measurements.

### Variance Estimate Scheme at Idaho Chemical Processing Plant

The explicit scheme which is used at I.C.P.P. to estimate variance components is as follows: periodically five *process* batches are randomly selected and designated as quality control batches. From each batch two samples are drawn, two aliquots from each of the duplicate samples are pipetted, spiked, and decontaminated independently of the others, and from each of the resulting solutions two aliquots of the precipitate are collected on filaments for mass-distribution analysis. Schematically the plan is shown in Figure A.

It is apparent from Equation (1) that the variation in the $\alpha_i$'s reflects the batch-to-batch variation. Similarly the variation in the $\beta_{j(i)}$'s for all $i$ and $j$ reflects the sample-to-sample variation. Furthermore, if the $\gamma_{k(ij)}$'s were known, they could be used to estimate the variation between preparations of the same sample. Finally, the average of the squares of the $\delta_{m(ijk)}$'s for all $m$, $i$, $j$, and $k$ would provide an estimate for the analytical component. Clearly the individual deviations are not available; however, by the method of analysis of variance the variance component estimates are readily computed from the data.

In the general case, for $n$ batches sampled according to the above scheme,

- $T_{\cdot(ijk)}$ = total of the two observations on the $k$'th preparation of the $j$'th sample from the $i$'th batch
- $T_{\cdot\cdot(ij)}$ = total of the four observations on the $i$'th batch and $j$'th sample from the batch
- $T_{\cdot\cdot\cdot(i)}$ = total of 8 observations on the $i$'th batch
- $T_{\cdot\cdot\cdot\cdot}$ = total of all $8n$ observations,

where

$$i = 1, 2, \ldots n;\ j = 1, 2;\ k = 1, 2$$

Symbolically the variance of the component deviations in Equation (1) are represented by

- $\sigma_\alpha^2$ for the $\alpha_i$'s
- $\sigma_\beta^2$ for the $\beta_{j(i)}$'s
- $\sigma_\gamma^2$ for the $\gamma_{k(ij)}$'s
- $\sigma_\delta^2$ for the $\delta_{m(ijk)}$'s

Then it can be shown (*1*) that

$\sigma_\delta^2$ is estimated by

$$\frac{\sum_{i,j,k,m} (x^2_{ijkm}) - \sum_{i,j,k} \frac{(T^2_{\cdot(ijk)})}{2}}{4n} \quad (2)$$

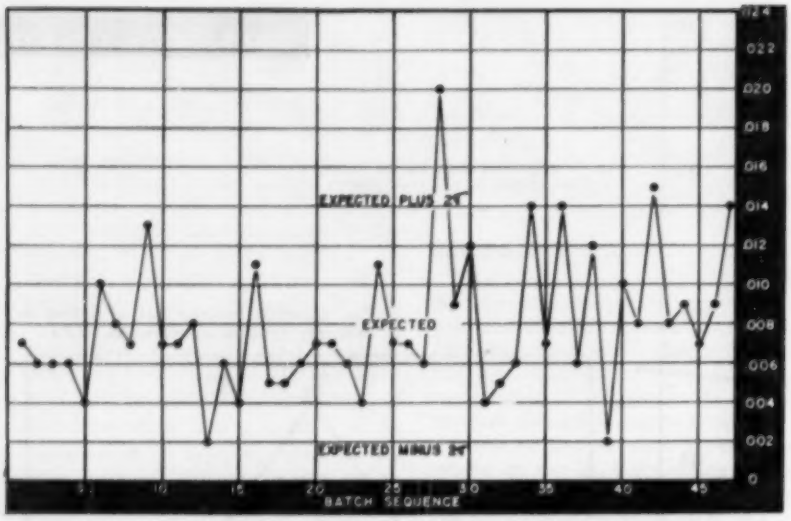



Fig. 2. Changes in specific gravity from dissolver to coarse-feed tank, compared with expected change.

$\sigma_\delta^2 + 2\sigma_\gamma^2$ is estimated by

$$\frac{\sum_{i,j,k} \frac{(T^2_{\cdot\cdot ijk})}{2} - \sum_{i,j} \frac{(T^2_{\cdot\cdot ij})}{4}}{2n} \qquad (3)$$

$\sigma_\delta^2 + 2\sigma_\gamma^2 + 4\sigma_\beta^2$ is estimated by

$$\frac{\sum_{i,j} \frac{(T^2_{\cdot\cdot ij})}{4} - \sum_{i} \frac{(T^2_{\cdot\cdot\cdot i})}{8}}{n} \qquad (4)$$

$\sigma_\delta^2 + 2\sigma_\gamma^2 + 4\sigma_\beta^2 + 8\sigma_\alpha^2$ is estimated by

$$\frac{\sum_{i} \frac{(T^2_{\cdot\cdot\cdot i})}{8} - \frac{(T^2_{\cdot\cdot\cdot\cdot})}{8n}}{n-1} \qquad (5)$$

The individual component estimates are easily derived from this set of equations. The usefulness of these component estimates is immediate. By a comparison of the magnitude of these estimates it is apparent where effort should be exerted to reduce the variability. Furthermore, the anticipated precision of any sampling-sample preparation-analysis scheme can easily be derived. Thus, a 95% confidence interval for true batch concentration where the reported result is the average of $n_1$ analyses each on $n_2$ preparations of each of $n_3$ samples drawn from the batch is given approximately by

$$\text{Avg.} \pm 2\sqrt{\frac{\sigma_\beta^2}{n_3} + \frac{\sigma_\gamma^2}{n_2 n_3} + \frac{\sigma_\delta^2}{n_1 n_2 n_3}}$$

If several analyses are to be performed on each batch, an examination of these three variance components will indicate where the increased effort should be spent in order to effect the greatest reduction in imprecision. Furthermore, such an evaluation is a prerequisite to any optimum allocation study of number of samples and number of analyses per sample to minimize any given "potential" loss function.

### Results

It was interesting to observe that the first application of this design resulted in an over-all precision estimate to be associated with a single analysis on a single preparation of a single sample drawn from a given batch of about ±20%, the sample preparation component being grossly larger than any other. Accordingly, a reexamination of this step in the measurement was made. It was found that a modified manipulation of the remote pipetter, and standardized technique in the sample decontamination step produced an improvement in the reproducibility. Thus, when the design was repeated, the over-all precision had evidently improved considerably, such that it was by then possible to attach a 95% limit of uncertainty to a single measurement as described above, of ±5.4%. In addition, it is emphasized that this is expressed as *tank* concentration uncertainty. Previously evaluation of plant data demonstrated that this uncertainty was of the order of ±30%.

### Control of Systematic Error

A program for control of systematic error associated with crude feed solution was effected under the following plan. For several reasons a program based only on synthetic bias control samples was felt to be inadequate in the surveillance of systematic errors. In many cases in which there appeared to be a bias associated with the method based on controls, it was found that the apparently true content of the synthetic was in error, or had shifted owing to evaporation or other factors. Furthermore, especially with regard to synthetic samples analyzed in replicate simultaneously or over a fairly narrow time interval—as in the case of gravimetric uranium—it was found that the day-to-day, or time effect on the samples greatly exceeded the variation between the replicates. Thus, the existence and magnitude of the bias depended to a large extent upon the time when the synthetics were submitted to the laboratory. (It should not be construed that such a situation is peculiar to this laboratory alone.)

To augment the program of synthetic control samples which, by the way, was reduced by a factor of 5, three modes of surveillance were simultaneosuly put into effect.

*The first mode* consisted in running bench standards previous to the analyses of any series of process samples. These bench standards are fabricated with extreme precision and are changed frequently. The reduction in routine quality control samples enabled the standards laboratory to exercise more care in preparing and handling the bench standards and also in more frequent compounding. The synthetic solutions are then analyzed in replicate by a Special Analysis Group to establish the true level of the component measured and the precision that can be expected on these samples. Based on the established precision of the *method* as determined by the replicate analyses on the synthetic samples, rerun limits are provided the analysts for each technique-sample combination. The limits are determined by an application of the theory of "statistical tolerance limits" to the samples. Any significant deviation from the stated level is called to the attention of the shift supervisor who in turn attempts to determine the cause of the excessive deviation. Such a program results in a closer surveillance of the laboratory technicians by the shift supervisor, and tends to standardize the methods.

*The second mode*, which was found to be extremely valuable, is based upon a regression analysis (*1*) of the process variables of the system. Data collected during steady-state operations can be subjected to statistical analysis in order to identify those parameters whose effects are significant. All these variables may well be significant between major changes in operating conditions, but day-to-day effects of minor changes in certain variables, or major changes in variables the effect of which is minor, can be ignored. The technique of regression analysis, that is, evaluation of *best estimates* of the parameters provides an empirical equation relating the significant variables.

Thus, dissolver effluvium contains uranyl nitrate, nitric acid, mercuric ni-

trate, and fission product in solution. For the usual, batch-by-batch day-by-day cases, none of these parameters will change over a wide range. At a fairly constant level of burn-up, charging a constant number of slugs or fuel elements to each batch, starting with the same acid concentration, mercuric nitrate content, and so on, a system of measurement limits can be established, deviation from which provides a prompt signal that closer surveillance is required. In this manner, regression analysis of plant data provided a relationship between uranium concentration, solution specific gravity, and acidity. From this equation uranium concentration corresponding to a batch specific gravity and acidity can be predicted as well as the uncertainty in this prediction.

For laboratory reference, the equation was represented in nomograph form and, by computation of the relevant limits of uncertainty surrounding this predicted value, an independent check of the laboratory measurement of uranium concentration was provided. Accordingly, when the uranium concentration measurement was found to differ by more than 0.09 concentration units from the value indicated by the nomograph, the analysis was rerun. Results have been extremely satisfactory. The nomograph is illustrated in Figure 1.

An additional degree of process surveillance was effected on *changes* in process variables in sequential steps. For example, acidity and specific gravity were measured both in the dissolver and crude feed solution tank. The solution transfer is effected by steam-jet eductors, hence a slight decrease in each of these variables can be anticipated. Analysis of plant data provided limits for control charts to show the expected change, dissolver to coarse-feed tank. As above, deviations signal possible trouble. Typical charts are illustrated in Figures 2 and 3.

*The third method* which proved valuable is the estimation of burn-up, and thence, residual uranium content of spent fuel by $U^{236}$ balance. To the degree that a stoichiometric relationship exists between the $U^{236}$ produced and the $U^{235}$ fissioned, one can write,

$$\text{g. residual uranium} = \frac{(\text{g. cold-U})(a)}{a + z} \qquad (6)$$

where

$z$ denotes atom fraction of $U^{236}$

$a$ denotes the capture-to-fission nuclear cross-section ratio for $U^{235}$, a physical property (*2, 3, 6*).

Grams of uranium prior to fissioning (cold-U) is determined from shippers' and fabricators' data, and a local piece-count.

**Spent-Fuel Dissolver Operating Limits**

As mentioned in a preceding section, a valid input measurement with the associated limits of uncertainty is crucial to optimum dissolver operation under the nuclear-criticality limitations. Similarly, the validity of the stated residual $U^{235}$ content of the spent reactor fuel elements is just as important since the residual fissionable material in a dissolver at any given time is equal to the cumulative amount charged as calculated from shipper's figures less the cumulative amount dissolved as measured batch-wise by the isotopic-dilution method of analysis. The "operating line" for a dissolver, that is, the cumulative allowable charge appropriate for each successive batch, reflects this heel calculation and the associated uncertainty in the calculations. The usual definition of the limits of uncertainty (5% risk of error) seems inadequate, in view of the possible consequences of an inaccurate estimate. For this reason the heel uncertainty was estimated with an approximate *1:10,000* risk, which was felt to be adequate since the dissolvers rarely run more than 80 consecutive batches before a complete cleanout is effected.

Little information is available from which the random errors associated with a given dissolver charge can be deduced. Usually all fuel elements of a given type have the same nominal uranium cold content and enrichment factor, and will have been apportioned reactor energy according to the estimated distribution curves. Any systematic error, however, will be reflected in the accuracy with which the residual heel is estimated over various dissolver runs on the assumption that the amount dissolved as determined by the isotopic dilution method is in control.

In application of the equation for heel uncertainty calculations, the anticipated extreme in amount dissolved and in dissolver charge over a given run was used in lieu of the average values, as was the extreme in the burn-up associated with a given batch. Thus, the equation becomes a function primarily of $n$, the batch number, and reduces to a form amenable to easy solution.

**Operating Line Derivation**

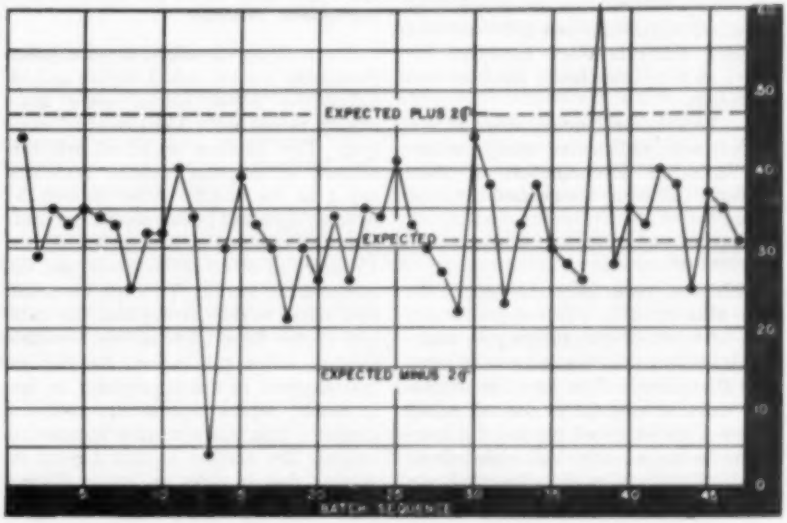
In the case of a particular type of fuel, where the number of fuel elements or slugs charged to each cycle is fixed, and information is available regarding the unirradiated and irradiated content of the material, an operating line equation could have the form,

$$D_n = A - \{(x_b B n)^2 + (x_r B \sqrt{n})^2 + [C \sqrt{n'}]^2\}^{1/2} \qquad (7)$$

where

- $D_n$ denotes maximum allowable dissolver charge for batch $n$
- $A$ denotes maximum allowable dissolver charge when heel uncertainty is zero
- $x_r$ denotes the random uncertainty or imprecision of the measurement method
- $x_b$ denotes uncertainty in the estimated bias of the analytical method
- $B$ denotes maximum expected amount of material dissolved per batch
- $C$ denotes maximum expected uncertainty in the estimate of burn-up attributed to the material by the shipper
- $n'$ denotes a modified function of $n$ to adjust for variations in charging procedure at the beginning of a run.

Fig. 3. Changes in acid normality from dissolver to coarse-feed tank, compared with expected change.



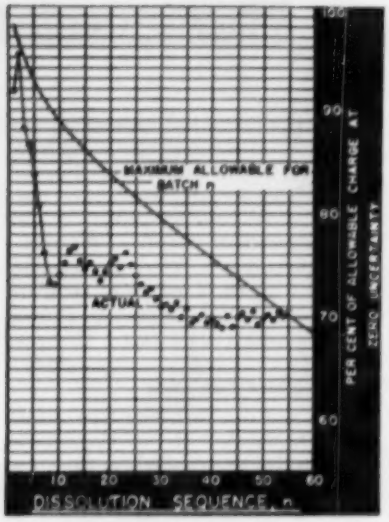



**Fig. 4. Dissolver charge sequence expressed as per cent of allowable at zero heel uncertainty.**

In practice it was found that the locus of dissolver charges intersects the operating line at about 60 batches. Safe operation is then effected either by reducing the heel by a dissolution cycle without a charge or by reducing the charge size. An examination of the operating line beyond the point of intersection with the locus of dissolver charges indicates that the frequency of the need for heel reductions increases; thus throughput drops sharply. Similarly with regard to charge size reduction, this tends to reduce the amount dissolved, by reducing the total amount of metal in the dissolver; hence the net effect is similar. A flexible charge-size program is considered undesirable, as this introduces an additional opportunity for operator error, as affecting the hazard represented by a multiple or erroneous dissolver charge. A schematic representation of dissolver operation is illustrated by Figure 4.

#### Use of Operating Line

A decision must be made at this point, therefore, to suffer either a somewhat reduced over-all dissolution rate, or a momentary gross reduction in dissolution rate by arresting charges altogether, and effecting complete dissolver clean-out. By clean-out, the heel uncertainties are forced to zero, and the locus of dissolver charges can be restored to the high values allowable at the beginning of the run. A usual dissolver clean-out will comprise six to eight dissolutions, with no fresh material being charged. With a knowledge of the average amount dissolved in each routine process batch, amortization of the accompanying loss of production can readily be shown.

Although the application of the methods discussed here has been in connection with specialized problems in uranium processing, their increasing acceptance by industry is testimony to their general applicability.

#### Literature Cited

1. Hald, A., "Statistical Theory with Engineering Applications," John Wiley & Sons, Inc., New York (1952).
2. BNL-250 (A.E.C. Classified Report) August 1, 1954.
3. BNL-276 (A.E.C. Classified Report) (January, 1954).
4. Bennett, C. A., and N. L. Franklin, "Statistical Analysis in Chemistry and the Chemical Industry," John Wiley & Sons, Inc., New York.
5. Mood, A. McF., "Introduction to the Theory of Statistics." McGraw-Hill, New York (1950).
6. Vance, F. P., and F. H. Tingey, *Nuclear Sci. Technol.*, **1**, No. 4 (A.E.C. Classified Report) (October, 1955).

## techniques

# RADIO-TAGGING SOLVES CATALYST ATTRITION PROBLEM

Recent work carried out in the Research and Technical Department of the Texas Company has brought out an interesting application of modern radio-tagging methods.

- *The Problem:* To determine relative attrition rates for two different fluid cracking catalysts when employed together as a mixture under fluidized bed conditions.
- *The Solution:* Impregnation of one catalyst with radioactive cobalt permitting accurate determination of fines fractions following accelerated attrition tests.

#### Materials Used

Both catalysts to be tested were of the 13% alumina–87% silica type, in the form of microspheres ranging in diameter from less than one micron to more than 80 microns. The basic impregnation solution was 0.6% normal cobalt nitrate solution to which, for the catalyst to be tagged only, was added about $7 \times 10^{-6}$ millicuries of radio cobalt per gram of catalyst. This concentration of radiocobalt was calculated to produce about 1000 counts per minute per gram of tagged catalyst to allow good counting accuracy with short counting times.

#### Impregnation Technique

About 75 to 80 milliliters of solution containing normal cobalt nitrate and/or radioactive cobalt nitrate were thoroughly mixed with 350 grams of catalyst. The catalyst could absorb this amount of solution without becoming moist to the touch. After mixing by hand to apparent homogeneity, the catalyst was calcined at 800 to 900° F. for 15 hours to drive off moisture and decompose the nitrate. This left the cobalt distributed evenly throughout the catalyst in the form of relatively insoluble oxides. After calcination, the catalyst was exposed to the atmosphere so that it would regain equilibrium moisture content. This was necessary because absolutely dry catalyst is such a good insulator that it picks up static charges and does not fluidize properly.

#### Measurement Technique

After the attrition tests, samples were calcined and then counted for gamma activity. Standard counting procedures were employed with a highly sensitive cup-type gamma ray detector and electronic scaling equipment. Two-gram samples were counted for 5-minute periods; 10-minute background counts were made at frequent intervals. Under these conditions, counting accuracy averaged ±1.5%.

#### Interpretation of Results

The above method permitted a mathematical resolution of the experimental data into separate attrition rates for each of the two components of the catalyst mixture.

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*Condensed from a paper, "Use of Radiotracing to Measure Relative Attrition Rates in Binary Mixtures of Fluid Catalyst," by A. J. Kinsella, Jr., Texas Co., presented at joint A.I.Ch.E.–A.C.S. meeting, Beaumont, Texas.*

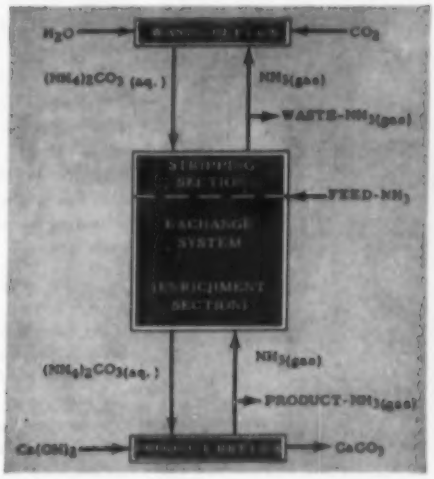


Fig. 1. Simplified flow diagram of the chemical exchange process for the production of $N^{15}$.

# $N^{15}$ COST when produced by the ammonia-ammonium carbonate separation process

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Isotopes may be separated by gaseous diffusion, electromagnetic separation, thermal diffusion, or chemical exchange. Of these techniques, chemical exchange is the most suitable for use in separating isotopes of the lighter elements. It depends on contacting two different chemical forms, each containing the element whose isotopes are to be separated. The difference in the bond energies in the two chemical forms tends to concentrate the lighter isotope in one chemical form and the heavier isotope in the other. Chemical separation of isotopes is analogous to the separation of components of a liquid mixture by fractional distillation except that, owing to much lower separation factors, many more stages are required in order to reach the desired product level.

The separation of nitrogen isotopes by chemical exchange has been the subject of a research and development program carried on by J. S. Drury and associates of the Isotope Separations Section of the Materials Chemistry Division. Several processes for separating nitrogen isotopes have been investigated. The cost estimate presented in this report is based on one of the more promising processes developed by that section.**

The purpose of this study is to establish an approximate cost of producing nitrogen enriched to 95 atom % $N^{15}$ through the utilization of this process. Two different-sized plants were considered: one was designed to produce 1 lb. of $N^{15}$/day and the other, 50 lb./day.

## Development of Process

A process for the separation of nitrogen isotopes by the chemical exchange between ammonia and an aqueous ammonium ion was first demonstrated by Urey and Aten in 1936 (*6*).

Recently the Isotope Separations Section has investigated the possibility of carrying out the separation of nitrogen isotopes by means of the exchange between ammonia and aqueous ammonium carbonate † according to the following equation:

$$2N^{15}H_{3(g)} + (N^{14}H_4)_2CO_{3(aq)} \underset{k_2}{\overset{k_1}{\rightleftharpoons}} 2N^{14}H_{3(g)} + (N^{15}H_4)_2CO_{3(aq)} \quad (1)$$

where $k_1/k_2 = \alpha$ = separation factor.

This exchange has been investigated extensively in the laboratory with a small packed column. The chemical exchange between ammonia and ammonium carbonate may be adapted to a continuous chemical exchange plant to produce enriched nitrogen isotopes by providing reflux for the exit streams at both the top and bottom ends of the exchange system, as shown in the simplified flow diagram in Figure 1.

Isotopically normal ammonia feed is introduced into the exchange columns. It joins the ammonia entering the stripping section from the enrichment section and flows to the waste reflux. The waste-level ammonia is slightly enriched in $N^{14}$. This ammonia is refluxed by reaction with carbon dioxide and water to form ammonium carbonate solution, which is pumped into the stripping section, through the enrichment section, and into the product reflux. The material at the product reflux is enriched in $N^{15}$.

The product reflux may be accomplished by reacting the ammonium carbonate with sodium or calcium hydroxide to form ammonia. The sodium hydroxide reflux system was utilized in the laboratory; however, calcium hydroxide was also tried and appears to be feasible and cheaper. Therefore, a calcium hydroxide product reflux is used for these cost estimates.

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This paper was presented at the first meeting of the American Nuclear Society.

* Messrs. Klima and Ward are affiliated with Pilot Plant Section, Materials Chemistry Division.

** Since this paper was written, another process has been developed by W. Spindel and T. I. Taylor (*5a*) at Columbia University, which utilizes isotopic chemical exchange between NO and $HNO_3$. An estimate (*1a*) has been made of the cost of nitrogen 15 produced by this newer method indicating that it would be $664/lb. at a production rate of 50 lb./day.

† This exchange system was suggested by H. C. Urey.

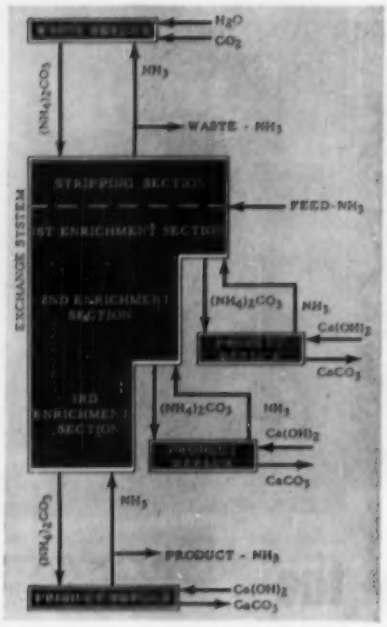



Fig. 2. General flow diagram.

**Table 2.—$N^{15}$ Isotope Concentration at Various Key Points of Cascade**

| Primary streams | Mole fraction of $N^{15}$ |
|---|---|
| Waste level | 0.0017 |
| Feed (normal) | 0.0038 |
| Top of first section (at first product refluxer) | 0.0116 |
| Top of second section (at second product refluxer) | 0.0650 |
| Product level (at third product refluxer) | 0.9500 |

Losses of nitrogen due to inefficient refluxing in the product reflux operation would appreciably increase the size and cost of the plant and consequently the cost of the product. These cost estimates are based on the principle of no loss occurring in the product reflux operation; that is, it was assumed that the product reflux would be 100% efficient and that all the nitrogen entering the product reflux in the aqueous solution would be returned to the system as ammonia gas, except for the small controlled product withdrawal.

Reflux at the waste end may be slightly inefficient without materially affecting the costs, since the ammonia recovered from the waste is not appreciably isotopically enriched and has no premium value.

On the assumption that 1 lb. of $N^{15}$ isotope would be produced/day, costs of plants and product were determined for three different variations of the process in order to find which would give the lowest product cost. The three cases studied were as follows:

CASE I

**The calcium carbonate formed in the product reflux is calcined to produce calcium oxide and carbon dioxide. The calcium oxide is then slaked for use in the product reflux. The calciner flue gas, which is rich in carbon dioxide, is used as the source of carbon dioxide for the waste reflux.**

CASE II

**The calcium carbonate formed in the product reflux is decomposed with sulfuric acid to form the carbon dioxide needed in the waste reflux. The resulting calcium sulfate is discarded. This case requires the purchase of calcium oxide for the product reflux, as well as the purchase of sulfuric acid. Dry ice is purchased and used as a source of make-up carbon dioxide.**

CASE III

**The calcium carbonate from the product reflux is discarded, calcium oxide is purchased for the product reflux, and dry ice is purchased and serves as the source of carbon dioxide for the waste reflux.**

A summary of plant costs and operating costs, together with product cost/lb. of contained $N^{15}$, both before and after credit has been allowed for sale of the waste ammonia, is given in Table 1.

The estimated cost/lb. of $N^{15}$ based on Case I is $4,014, which is lower than the estimates based on Cases II and III. Scaling-up the Case I estimate to a production rate of 50 lb./day lowers the cost/lb. to $1,079. A reduction in cost of approximately $25/lb. product might be realized if the waste ammonia can be sold. Sale of by-products such as calcium carbonate or calcium sulfate would further lower the costs.

**General Considerations**

The configuration chosen for the isotope exchange system is one which con-

**Table 1.—Summary of Plant Cost and Product $N^{15}$ Cost**

| | Plant producing 1 lb./day | | | Plant producing 50 lb./day * |
|---|---|---|---|---|
| | Case I | Case II | Case III | |
| Total plant investment | $3,251,240 | $3,174,169 | $2,907,341 | $38,638,590 |
| Total annual operating costs | 1,465,256 | 1,669,187 | 1,565,532 | 19,684,755 |
| Cost/lb. of $N^{15}$ | 4,014 | 4,573 | 4,289 | 1,079 |
| Credit for sale of waste ammonium (/lb. $N^{15}$) | 25 | 25 | 25 | 25 |
| Net cost/lb. $N^{15}$ | $ 3,989 | $ 4,548 | $ 4,264 | $ 1,054 |

* Process same as Case I.

**Table 3.—Cascade Configuration**

| Section | Stages | Column type | Column diam. (in.) | Column height (ft.) | Aqueous-phase flow (gal./min.) | Gas-phase flow std.cu.ft./min. |
|---|---|---|---|---|---|---|
| Stripping | 73 | Bubble-cap plate | 18 | 132 | 6.1 | 336 |
| First enrichment | 100 | Bubble-cap plate | 18 | 181 | 6.1 | 328 |
| Second enrichment | 140 | Packed | 10 | 175 | 2.0 | 107 |
| Third enrichment | 351 | Packed | 5 | 220 | 0.4 | 19 |

**Table 4.—Product Refluxer Configuration**

| Product refluxer | Diam., type of column | | Column height (ft.) | Aqueous flow from enrichment gal./min. | Gaseous flow to enrichment std.cu.ft./min. | 2 M $Ca(OH)_2$ slurry flow gal./min. |
|---|---|---|---|---|---|---|
| First | 20-in. | bubble-cap plate | 78 | 4.1 | 221 | 12.9 |
| Second | 14-in. | bubble-cap plate | 65 | 1.6 | 88 | 5.2 |
| Third | 10-in. | packed | 54 | 0.4 | 19 | 1.1 |

sists of three consecutive enrichment sections, each one having a throughput smaller than the preceding one. This requires a "product" refluxer at each of the points where the flow is reduced, as shown in the general flow diagram in Figure 2. Technically, a "product" refluxer is one that refluxes product-level material; in this plant it is the refluxer for the aqueous phase from the third enrichment section. However, since the refluxing process for the aqueous streams removed from the first and second enrichment sections is identical to that for the aqueous stream from the third enrichment section, all three refluxers are hereinafter called product refluxers.

A cascade of this type, in which the throughput is reduced at one or more points where a portion of the flow is refluxed, is called a tapered cascade. The isotopic assay at each of these points for the plant design used in this estimate is shown in Table 2.

A detailed description of each of the process sections of the plant follows. This description is for the Case I plant, where the calcium carbonate formed in the product refluxers is calcined to produce lime and carbon dioxide. The lime is then slaked for use in the product refluxers, and the flue gas, which is rich in carbon dioxide, is used as the source of carbon dioxide for the waste refluxers. The isotopic exchange, waste reflux, and product reflux sections of the plants are the same for all three cases. The variations entailed for Cases II and III will be discussed later. The flow diagram for Case I is shown in Figure 3.

#### Exchange System

The isotopic exchange takes place between gaseous ammonia and an aqueous solution of ammonium carbonate which is saturated with both ammonium carbonate and ammonia. The actual composition of the aqueous phase at the assumed operating temperature of 30° C. is approximately as follows:

$$6\ \underline{M}\ (NH_4)_2CO_3$$

$$6\ \underline{M}\ NH_3$$

The two phases are passed countercurrently through a series of columns, the $N^{15}$ isotope concentrating in the aqueous phase as it progresses through the system.

The exchange system consists of one stripping section and three enrichment sections. The feed stream, isotopically normal ammonia gas, enters the system between the first enrichment section and the stripping section. It joins the gaseous phase from the enrichment sections and flows through the stripping section to the waste refluxer. The aqueous phase from the waste refluxer flows through the stripping section and the first enrichment section and is then split into two streams. The larger stream flows to the first product refluxer. The smaller stream flows through the second enrichment section and is again split, the larger stream flowing to the second product refluxer and the smaller stream to the third enrichment section. The entire aqueous stream from the third enrichment section is sent to the third product refluxer. The plant is thus tapered by reducing the flow at two points in the enrichment exchange system.

The isotopic exchange takes place in columns. It was decided to use packed columns for diameters of 12 in. or less and bubble-cap plate columns where the required diameter is greater than 12 in. In addition to the columns, dump tanks

Fig. 3. Engineering flow diagram, $N^{15}$ cost estimate—Case 1.

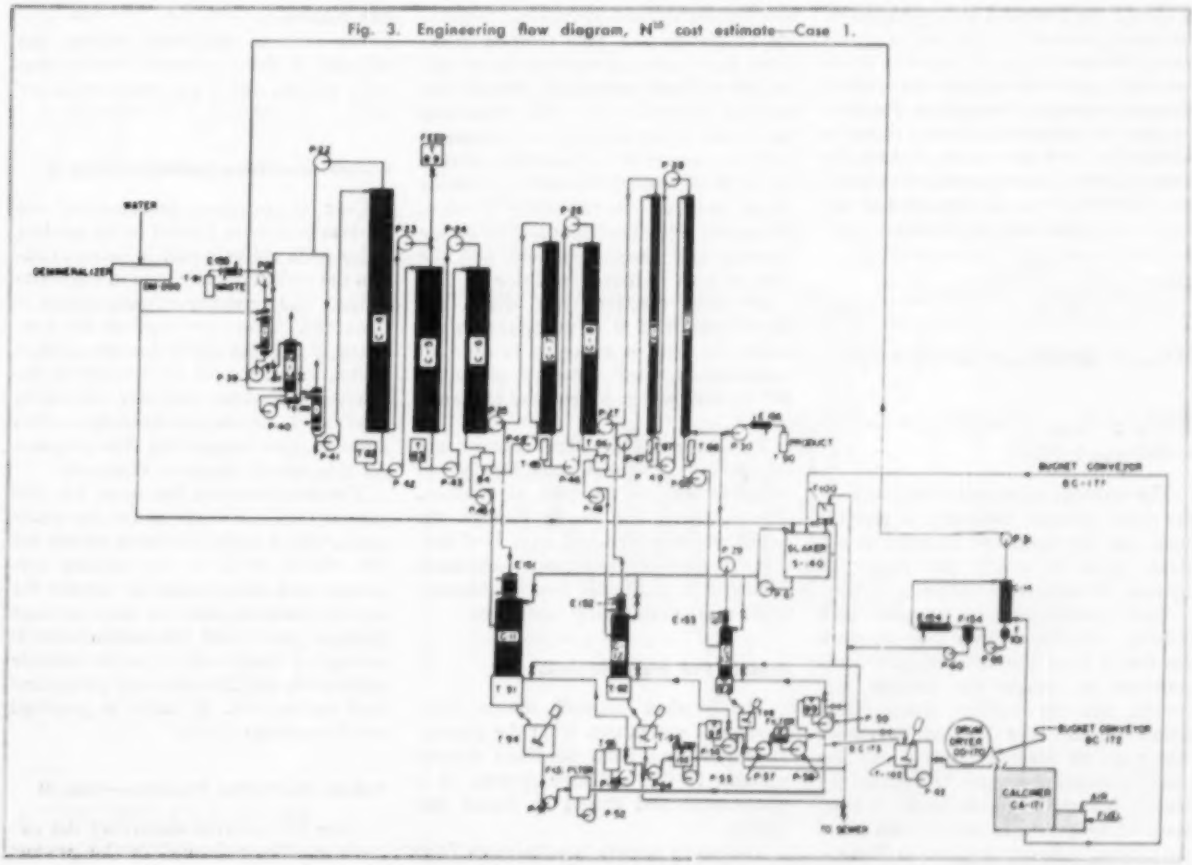


**Table 5.—Composition, Flow of Waste Reflux Streams**

| Waste reflux reactor | Gaseous phase entering composition | Gaseous phase entering flow (std.cu.ft./min.) | Aqueous phase entering composition | Aqueous phase entering flow (gal./min.) | Aqueous phase leaving composition | Aqueous phase leaving flow (gal./min.) |
|---|---|---|---|---|---|---|
| First | pure $NH_3$ saturated with water vapor | 112 | Demineralized $H_2O$ | 3.6 | 8.15 M $NH_4OH$ | 4.5 |
| Second | 34% $CO_2$ (Case I) | 322 | 8.15 M $NH_4OH$ | 4.5 | ~6.6 M $NH_4HCO_3$ | 5.5 |
| | pure $CO_2$ (Cases II and III) | 109 | | | | |
| Third | pure $NH_3$ saturated with water vapor | 224 | ~6.6 M $NH_4HCO_3$ | 5.5 | 6 M $(NH_4)_2CO_3$<br>6 M dissolved $NH_3$ | 6.1 |

and intercolumn pumps are required. A summary of the pertinent information about the exchange columns is given in Table 3.

#### Product Reflux

Three product-type refluxers are required, one for each aqueous stream leaving the enrichment exchange system. In each case the aqueous ammonium carbonate solution is admitted to a column supplied with steam from a reboiler. The point of entry is part way up the column, since approximately thirty stages are required below the feed point to reduce the ammonia concentration of the liquid phase to 1 p.p.m. and approximately thirteen stages are required above the feed point to reduce the carbon dioxide content of the gaseous phase to 1 p.p.m. A calcium hydroxide slurry is admitted at the top of the column to react with and remove the carbon dioxide. The reactions in the product refluxers are essentially as follows:

$$(NH_4)_2CO_{3(aq)} \xrightarrow{\text{heat}} 2NH_{3(g)} + CO_{2(g)} + H_2O \quad (2)$$

$$CO_{2(g)} + Ca(OH)_2 \rightarrow CaCO_3 + H_2O \quad (3)$$

$$(NH_4)_2CO_{3(aq)} + Ca(OH)_2 \rightarrow CaCO_3 + 2NH_{3(g)} + 2H_2O \quad (4)$$

The gaseous ammonia from each of the three product refluxers is pumped back into the exchange columns at the same point at which the respective aqueous streams were removed.

Each product refluxer consists of a column, reboiler, holdup tank to store the slurry from the reboiler, filter, belt conveyor to remove the calcium carbonate, and the required pumps. One slaker supplies the calcium hydroxide slurry to all three refluxers. All the slurry processing equipment (except the slaker) is installed in duplicate. A summary of the pertinent information about the product refluxers is given in Table 4.

#### Waste Reflux

The waste reflux is carried out in three steps as shown in the following reactions:

$$H_2O_{(aq)} + NH_{3(g)} \rightarrow NH_4OH_{(aq)} \quad (5)$$

$$NH_4OH_{(aq)} + CO_{2(g)} \rightarrow NH_4HCO_{3(aq)} \quad (6)$$

$$NH_4HCO_{3(aq)} + 2NH_{3(g)} \rightarrow (NH_4)_2CO_{3(aq)} + NH_{3(\text{dissolved})} \quad (7)$$

One third of the entering ammonia is reacted with the necessary water in the first reactor to form ammonium hydroxide (Equation 5). This solution is reacted with carbon dioxide in the second reactor to form ammonium bicarbonate solution (Equation 6). The remaining two thirds of the ammonia is then mixed with the ammonium bicarbonate solution in the third reactor to form the aqueous phase sent to the stripping column, (Equation 7). The composition of the aqueous and gaseous streams and the flow of each is shown in Table 5.

All three reactions just shown are exothermic, and it is necessary to remove the heat in order to provide an ammonia-saturated aqueous phase at 30° C. with which to feed the exchange system.

The three waste reflux reactors are designed as jacketed tube bundles in order to remove the heat of reaction. The reactants are passed through the tubes, which are packed with Berl saddles to provide maximum turbulence. Pumps and additional heat exchangers make up the remaining equipment.

#### Product and Waste Streams

The product take-off stream (ammonia) is withdrawn from the gaseous stream flowing from the third product refluxer to the exchange system. It is compressed and stored as liquid ammonia.

The waste stream is withdrawn from the gaseous ammonia flow from the stripping column to the waste reflux section. It is likewise compressed and stored as liquid ammonia.

#### Auxiliary Processes

The calcium carbonate filter cake taken from the product refluxers is reslurried, dried, and calcined. The calcium oxide from the calciner is slaked and used in the product reflux columns. Part of the flue gas from the calciner, after being cooled and scrubbed free of solid matter, is used as the source of carbon dioxide for the second waste reflux reactor.

The process equipment includes the calciner, a drum dryer, a reslurrying tank, pumps, and a gas cooler-scrubber unit.

#### Process Description Variations—Case II

Case II involves decomposing the calcium carbonate formed in the product reflux with sulfuric acid in order to obtain the carbon dioxide used in the waste reflux. The resulting calcium sulfate is discarded. This case requires the purchase of calcium oxide for the product reflux, sulfuric acid to decompose the calcium carbonate, and dry ice to be used as a source of make-up carbon dioxide. The engineering flow diagram for this case is shown in Figure 4.

The equipment is the same for this case as for Case I, except for the auxiliaries, which include reaction vessels for the neutralization of the calcium carbonate with sulfuric acid to recover the carbon dioxide, sulfuric acid storage tanks, a gas holder for carbon dioxide storage, a small bank of carbon dioxide generators, and the necessary pumps and heat exchangers. A slaker is provided for the calcium oxide.

#### Process Description Variations—Case III

Case III involves discarding the calcium carbonate formed in the product

reflux. Calcium oxide is purchased for the product reflux and dry ice is purchased as the source of carbon dioxide for the waste reflux. The engineering flow diagram for this case is shown in Figure 5.

The equipment is the same for this case as for Case I, except for the auxiliaries, which include dry-ice gasifiers in addition to the calcium oxide slaker.

### Bases of the Design

#### PLANT CAPACITY

The plant was designed to produce 1 lb. of contained $N^{15}$/day at an enrichment level of 95% $N^{15}$. A second cost estimate, also included in this report, is for a plant to produce 50 lb. of contained $N^{15}$/day at the same level of enrichment. The following information refers to the plant designed to produce 1 lb./day unless otherwise noted.

#### MATERIALS OF CONSTRUCTION

Mild steel was selected as the primary material of construction on the basis of published corrosion data (*2*).

#### ISOTOPIC EXCHANGE SYSTEM

1. separation factor ($N^{15}$ concentrating in the aqueous phase), 1.02
2. gaseous phase, pure $NH_3$ saturated with water vapor
3. all columns to be insulated

#### PRODUCT REFLUX SYSTEM

1. $CO_2$ content of gas phase leaving—1 p.p.m. or less
2. $NH_3$ content of $CaCO_3$ slurry leaving—1 p.p.m. or less
3. concentration of $Ca(OH)_2$ slurry entering—2 M
4. temperature of $Ca(OH)_2$ slurry entering—90° C.
5. calcium hydroxide slurry used—5% over stoichiometric amount
6. desorption of ammonia in presence of excess calcium hydroxide slurry based on data (*3*), giving number of plates vs. $NH_3$ concentration extrapolated to determine number of stages to obtain 1 p.p.m. $NH_3$ in liquid withdrawn
7. number of stages necessary to strip $CO_2$ content of the ammonia stream to 1 p.p.m. with lime slurry calculated by the equation (*4*)

$$N_a = \ln\left[\frac{\ln (1 - y_1)}{\ln (1 - y_2)}\right]$$

where

$y_1$ = mole fraction $CO_2$ at feed point

$y_2$ = mole fraction $CO_2$ in gas phase leaving

8. reflux columns and reboilers to be in duplicate
9. each product refluxer to have its own filter and storage tanks
10. all parts of product refluxers to be insulated.

#### WASTE REFLUX SYSTEM

1. reaction rate for absorbing ammonia in water: transfer coefficient $K_{Ga} = 32$ lb. moles/(hr.)(cu.ft.)(atm.) at 25° C. at a liquid rate of 10,000 lb./(hr.)(sq.ft.) with 1-in. Intalox saddle packing (*7*)
2. reaction rate for absorbing carbon dioxide in ammonium hydroxide—same as that for ammonia in water (assumed)
3. reaction rate for absorbing ammonia gas in ammonium bicarbonate—same as that for ammonia in water (assumed)
4. temperature of aqueous phase entering second reactor—30° C.
5. temperature of aqueous phase leaving second reactor—40° C.

#### PRODUCT

1. quantity of $N^{15}$ in product/day—1.000 lb.
2. quantity of ammonia product/day—1.197 lb.

#### FEED

1. quantity of ammonia fed/day—540 lb.

#### WASTE

1. quantity of ammonia waste/day—539 lb.

#### GENERAL

1. for columns larger than 12 in. diam.—bubble-cap plates
2. assumed efficiency of bubble plate columns—60%
3. for columns 12 in. diam. or less—packed columns (Intalox saddles)
4. stage height for packed columns—1.5 × diam. (but not less than 0.6 ft.)
5. maximum column height (columns to be equally divided if necessary) —150 ft.
6. all column installations to be outside of buildings.

### Bases for Estimating Costs

The cost of producing the $N^{15}$ isotope may be divided into two types: namely,

1. *Fixed costs.*—These include (a) investment costs, such as depreciation, interest on invested capital, and taxes, and (b) overhead.

2. *Variable costs.*—These include raw materials, labor, utilities, maintenance, supplies, packaging, storage, and shortages.

The method employed in determining these costs is outlined in the following paragraphs.

#### PLANT COSTS

The plant costs are estimated as follows:

(a) *Installed equipment.*—Almost all data on the prices for installed equipment were obtained from (*1*) and adjusted to the 1953 cost level. Prices for a few of the items were obtained directly from the manufacturer. If equipment is to be insulated, a premium of 10% of the installed-equipment cost was added.

(b) *Process piping.* [0.60 times installed-equip-

Fig. 4. Engineering flow diagram, $N^{15}$ cost estimate—Case II.

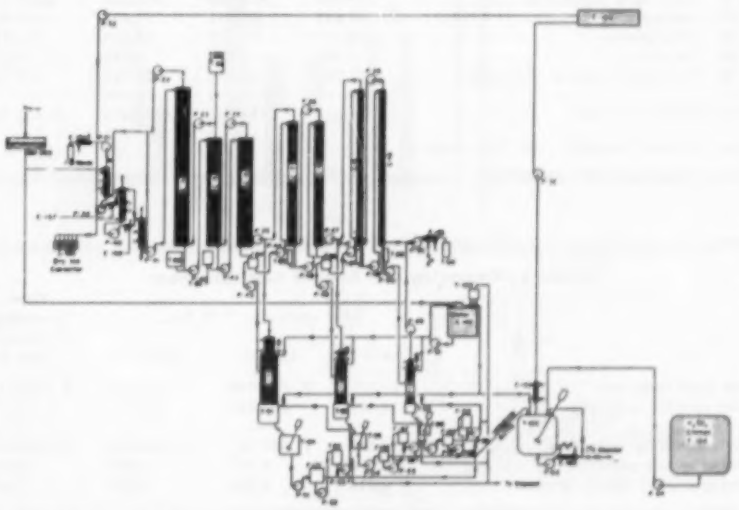


**Table 6.—Investment Cost Summary**

| Code letter | Cost designation | Plant producing 1 lb./day Case I | Case II | Case III | Plant producing 50 lb./day * |
|---|---|---|---|---|---|
| a | Installed equipment | $ 624,560 | $ 603,670 | $ 552,995 | $ 7,377,095 |
| b | Process piping | 374,740 | 362,200 | 331,795 | 4,426,260 |
| c | Instrumentation | 87,440 | 84,510 | 77,420 | 1,032,795 |
| d | Process buildings | 187,370 | 181,100 | 165,900 | 2,213,130 |
| e | Laboratory furniture and equipment | 18,740 | 18,110 | 16,590 | 221,310 |
| f | Service facilities | 187,370 | 181,100 | 165,900 | 2,213,130 |
| g | Total physical plant | $1,480,220 | $1,430,690 | $1,310,600 | $17,483,720 |
| h | Engineering | 592,090 | 572,280 | 524,240 | 6,993,490 |
| i | Site development | 93,680 | 90,550 | 82,950 | 1,106,565 |
| j | Preoperational cost | 592,090 | 572,280 | 524,240 | 6,993,490 |
| k | Contingency | 370,055 | 357,670 | 327,650 | 4,370,930 |
| l | Working capital | 123,105 | 190,699 | 137,661 | 1,690,395 |
| m | Total plant investment | $3,251,240 | $3,174,169 | $2,907,341 | $38,638,590 |

* Same Process, Case I.

**Table 7.—Fixed Cost Summary**

| Cost designation * | Plant producing 1 lb./day Case I | Case II | Case III | Plant producing 50 lb./day (Case I) |
|---|---|---|---|---|
| Investment cost/year | | | | |
| (1) Depreciation | $469,220 | $453,521 | $415,452 | $5,542,229 |
| (2) Interest on fixed capital | 31,281 | 30,235 | 27,697 | 369,482 |
| (3) Interest on working capital | 1,231 | 1,507 | 1,377 | 16,904 |
| (4) Payment in lieu of taxes | 31,281 | 30,235 | 27,697 | 369,482 |
| Overhead cost/year | $320,560 | $299,440 | $292,835 | $3,472,659 |
| Total fixed cost/year | $853,573 | $814,938 | $765,058 | $9,770,756 |

* These costs are discussed under Plant Costs (n).

**Table 8.—Variable Cost Summary**

| Cost designation * | Plant producing 1 lb./day Case I | Case II | Case III | Plant producing 50 lb./day (Case I) |
|---|---|---|---|---|
| (1) Raw materials | $ 78,796 | $341,516 | $303,454 | $3,939,800 |
| (2) Labor and supervision | 341,640 | 315,360 | 315,360 | 3,587,220 |
| (3) Utilities | 88,813 | 85,841 | 78,636 | 1,049,025 |
| (4) Maintenance | 74,011 | 71,535 | 65,530 | 874,186 |
| (5) Supplies | 7,401 | 7,153 | 6,553 | 87,419 |
| (6) Packaging, storage, shortages | 21,022 | 32,844 | 30,941 | 376,351 |
| Total variable cost/year | $611,683 | $854,249 | $800,474 | $9,913,999 |

These costs are discussed under Plant Costs (o)

**Table 9.—Operating and Product Costs Summary**

| | Plant producing 1 lb./day Case I | Case II | Case III | Plant producing 50 lb./day (Case I) |
|---|---|---|---|---|
| Total fixed costs/year | $ 853,573 | $ 814,938 | $ 765,058 | $ 9,770,756 |
| Total variable costs/year | 611,683 | 854,249 | 800,474 | 9,913,999 |
| Total operating costs/year | $1,465,256 | $1,669,187 | $1,565,532 | $19,684,755 |
| Total operating cost/day | 4,014 | 4,573 | 4,289 | 53,931 |
| Total operating cost/lb. product | 4,014 | 4,573 | 4,289 | 1,079 |

ment cost (a)].—C. H. Chilton (7) recommended a factor of 30 to 60% for fluids-processing plants. Because of the extreme importance of providing a leaktight installation, the maximum factor was chosen.

(c) *Instrumentation* [0.14 times installed-equipment cost (a)]—A factor ranging from 2 to 15% was recommended (7). A value close to the maximum was chosen because of the need for close flow control.

(d) *Process buildings* [0.30 times installed-equipment cost (a)]—Chilton recommended a factor of 20 to 60% for mixed indoor-outdoor construction. Since the columns, which constitute a major portion of the equipment (space-wise) can be installed outdoors, a factor of 30% was chosen.

(e) *Laboratory furniture and equipment* [0.03 times installed equipment cost (a)]—This factor was based on local experience.

(f) *Service facilities* [0.30 times installed-equipment cost (a)]—For complete facilities at a new site a factor of 25 to 100% was recommended (7). Since the utilities requirements are not unusually large, the relatively low factor of 0.30 was chosen.

(g) *Total physical plant*—This is the sum of the costs given in items a, b, c, d, e, and f.

(h) *Engineering* [0.4 times the total physical plant (g)]—According to (7) this factor will vary from 35 to 50% in cases where the engineering is complex and a high labor-to-materials ratio exists.

(i) *Site development* [0.15 times installed-equipment cost (a)]—H. E. Schweyer (5) gives a range of from 0.09 to 0.28 for this factor.

(j) *Preoperational costs* [0.4 times the total physical plant (g)]—This cost includes leak testing, equipment shakedown, operator training, and other start-up costs incurred prior to routine operation.

(k) *Contingency* [0.25 times the total physical plant (g)]—A factor of 20 to 30% of the total physical cost for an average plant which is subject to change was recommended (7).

(l) *Working capital.*—This item includes the cost of material inventories and in-process materials plus the cost of one month's operation.

(m) *Total plant investment.*—This is the sum of the cost of the total physical plant, engineering costs, site development, preoperational cost, contingency, and working capital ($g + h + i + j + k + l$).

(n) *Fixed costs.*—The fixed costs are a sum of the investment and overhead costs. The investment costs include the following:

(1) Depreciation.—15% of the total plant investment minus the working capital [0.15 ($m - 1$)], which is the standard rate of depreciation used for A.E.C. installations.

(2) Interest charge on total fixed capital.—assumed to be 1%/year of the total plant investment minus the working capital [0.01 ($m - 1$)].

(3) Interest charge on working capital.—assumed to be 1%/yr. of the working capital ($0.01 \times 1$).

(4) Payment in lieu of taxes.—assumed to be 1%/yr. of total plant investment minus the working capital [0.01 ($m - 1$)].

Overhead costs are assumed to be the sum of the following: (1) 70% of the cost of labor and supervision, and (2) 100% of cost of maintenance and supplies.

(a) *Variable costs*

(1) Raw materials consumed/yr.—raw-materials costs based on current market prices and calculated usages.

(2) Direct labor and supervision.—personnel requirements estimated after reviewing manpower estimates for three other plants and considering these in conjunction with local experience. A charge of $3.00/man-hour assumed.

(3) Utilities [0.06 times the total physical plant (g)]—includes all the electricity, water for domestic use only and steam for general heating (buildings, etc.) only. The process water, cooling water, and steam used for process heating are included under raw materials.

(4) Maintenance [0.05 times the total physical plant (g)]—This factor based on local experience.

(5) Supplies [0.005 times the total physical plant (g)]—This factor based on local experience.

(6) Packaging, storage, shortage, etc.—0.05 times the sum of cost of raw materials and cost of labor and supervision.

## COST PER POUND

The cost per pound of product is the sum of the annual fixed costs plus the annual variable costs, divided by 365 days and the daily production rate.

## SCALE-UP METHOD

The scale-up method was used for determining cost/lb. at a production rate of 50 lb./day. The process described for Case I was used as the basis for the scale-up calculations. The methods employed in scaling-up the plant costs are summarized below:

The sizes of the exchange columns (both diameters and lengths) were recalculated by the use of the increased flow rates. The cost of these columns was then obtained from prices (*1*). From these costs a cost increase factor was calculated, which was used to scale up and determine the cost of the product reflux columns. Cost of the rest of the equipment was calculated by means of the 0.6 factor (*8*).

The total plant investment was calculated from the cost of the installed equipment as described for the 1 lb./day plant.

Fixed costs were calculated in the manner as described for the 1 lb./day plant. Variable costs were calculated as described for the 1 lb./day plant with the following exceptions:

(a) *Raw materials*—The raw-materials consumption was assumed to be exactly fifty times that for the 1 lb./day production rate.

(b) *Labor and supervision*—The cost of labor and supervision for the 1 lb./day plant (Case I) was scaled up by the use of the 0.6 factor (*8*).

The cost/day was then calculated as described for the 1 lb./day plant.

## Cost Estimate

The cost of producing 1 lb./day of $N^{15}$ with an isotopic purity of 95 mole % for each of the three cases is:

for Case I—$4,014/lb. of $N^{15}$
for Case II—$4,573/lb. of $N^{15}$
for Case III—$4,289/lb. of $N^{15}$

When the plant, based on Case I, is scaled up to a production rate of 50 lb./day, the cost becomes $1,079/lb. of $N^{15}$.

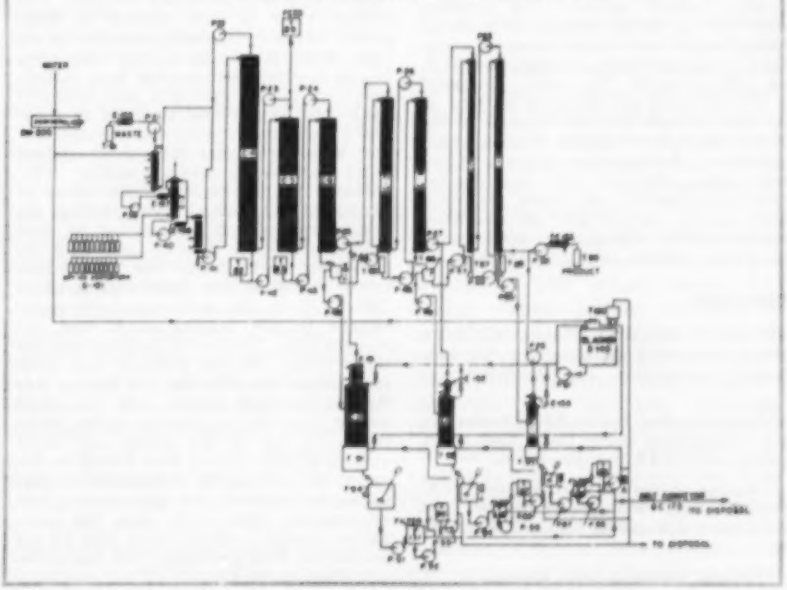
The cost for Case I proved to be the lowest because the raw-materials consumption is much less than that in Cases II and III. The raw-materials costs, as related to the total production costs, are as follows:

for Case I— 5.4% of production cost
for Case II—20.5% of production cost
for Case III—19.4% of production cost

A breakdown of the investments costs, the fixed costs, and the variable costs for each of the three cases and for the scale-up, are given in Tables 6, 7, and 8, respectively. A summary of these costs is given in Table 9.

It should be noted that no credit was allowed for the value of the waste ammonia or for the by-products produced in Cases II and III (calcium sulfate and calcium carbonate, respectively), any or all of which might have resale value.

Fig. 5. Engineering flow diagram, $N^{15}$ cost estimate—Case III.



## Literature Cited


1. Chilton, C. H., *Chem. Eng.*, **56**, 97-106 (1949).
1a. Klima, B. B., W. T. Ward, R. R. Wiethaup, and J. S. Drury, O.R.N.L.-CF-55-1-22 (January 14, 1955).
2. Nelson, G. A., "Corrosion Data Survey," San Francisco, California, Shell Development Company (1950).
3. Parish, P., "The Design and Working of Ammonia Stills," D. Van Nostrand, New York (1924).
4. Perry, J. H., "Chemical Engineers' Handbook," 3 ed., p. 702, McGraw-Hill Book Co., Inc., New York (1950).
5. Schweyer, H. E., *Chem. Eng. News*, **31**, 3266-3270 (1953).
5a. Spindel, W., and T. I. Taylor, *J. Chem. Phys.*, **23**, No. 5, 981-982 (May, 1955).
6. Urey, H. C., and A. H. W. Aten, Jr., *Phys. Rev.* **50**, 575 (1936).
7. Wen, Chin-Yung, M.S. Thesis, Chemical Engineering, University of West Virginia (1953).
8. Williams, R., *Chem. Eng.*, **54**, 124-125 (1947).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# coolant technology of a PRESSURIZED WATER NUCLEAR POWER PLANT

## A two-year review of operating experience

*Irving H. Welinsky,* Paul Cohen,† and James H. Seamon ‡*

A full-scale nuclear power plant of the pressurized water type has been in successful operation at the National Reactor Testing Station in Idaho since the spring of 1953, with only brief shutdowns for modifications. This report reviews the chemical engineering experience gained with the primary water coolant during the first two years.

### Description of the Plant

#### PRIMARY WATER LOOP

Figure 1 is a schematic flowsheet of the primary coolant system. The primary water loop as shown consists of a closed piping loop in which the water is maintained at an average temperature of 450° F. and 2,000 lb./sq.in. The water, circulated by canned rotor pumps, picks up heat at the fuel element surfaces housed in the reactor vessel and transfers it to the steam generator. The actual plant contains two such loops integrated with one reactor. Each loop contains one steam generator, three pumps, valves, and the necessary instrumentation. Circulation rates are in the range upwards of 10,000 gal./min.

#### PRESSURIZER

Pressure control is maintained by a pressurizer vessel connected to the loop through a surge line. The pressurizer vessel is partly filled with water maintained at 633° F. by electric immersion heaters. Pressure surges in the primary loop, which result from power changes, are transmitted through the surge line to the pressurizer where they are absorbed by the steam head above the water level.

#### PURIFICATION SYSTEM—FILTER AND DEMINERALIZER

The plant contains a purification system to remove impurities which accumulate in the water from corrosion of equipment. A by-pass line from the primary loop leads first to a sintered stainless steel filter having a mean pore size of 10$\mu$ designed to remove suspended corrosion products. The filtered water is then pumped to three points: (1) to hydraulically operated valves from which it returns to the filter inlet, (2) to a strong acid, strong base, mixed-bed resin in the hydrogen and hydroxyl ion forms. The influent is cooled to about 130° F. by a regenerative and nonregenerative heat exchanger. The demineralized water then passes through another filter which traps any resin leakage. Part of the cooled and purified water services the reactor control rod mechanisms by first cooling the drive motors and then by lubricating and cooling the mechanisms themselves which are maintained at about 250° F. From the mechanisms, the water returns to the reactor vessel and the primary loop. The rest of the demineralized water returns to the primary loop after exchanging heat with the line leading into the demineralizer system. (3) The third stream from the purification system pump enters the top of the pressurizer vessel as a spray after having been heated by the pressurizer effluent in a regenerative heat exchanger (called the pressurizer heat exchanger). The water from the pressurizer returns to the primary loop via the pressurizer heat exchanger and the aforementioned surge line.

#### MATERIALS OF CONSTRUCTION

The materials of construction are predominantly stainless steel. In terms of total surface area contacted by primary water (other than fuel elements), the approximate percentages are type 347, 80%; special stainless, 10%; and nonferrous, 10%.

### Materials Selection and Purification System Design

Adequate corrosion resistance of materials is important in any plant. In this particular type of plant, there are special problems associated with corrosion which were anticipated early in the project.

#### STRUCTURAL REQUIREMENTS AND PERFORMANCE OF COMPONENTS

It is important that containing structures such as piping and vessels undergo no unusual corrosion which would impair their performance. Because of the known superior corrosion resistance of the austenitic steels, early efforts in the laboratory were devoted largely to a study of the corrosion resistance of this group. Type 347 stainless steel was chosen as the most suitable material for a first venture into the nuclear power field. At 500° F., in pure water it has a corrosion rate of the order of 10 mg./(sq.dm.)(month), or a penetration rate less than 0.1 mils/yr. The surface corrodes uniformly, and in these tests no special corrosion

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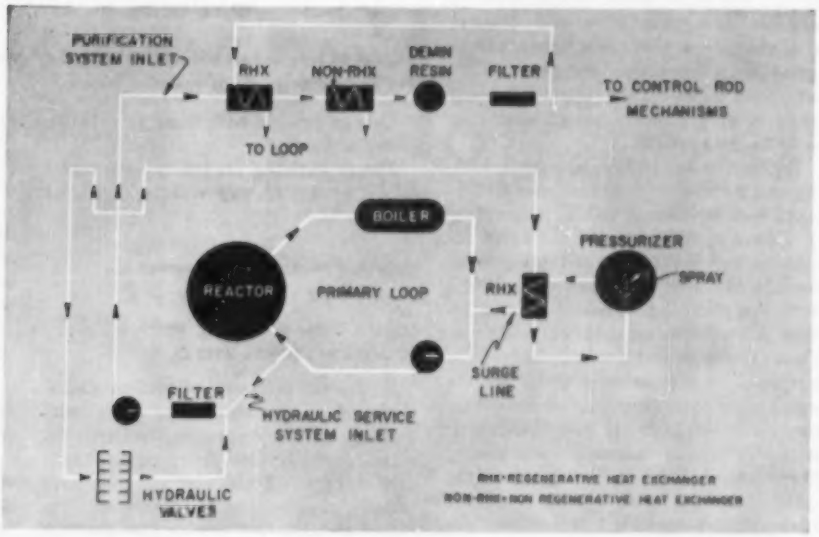


Fig. 1. Primary loop of pressurized water nuclear power plant.

behavior was observed which might impair its long-time performance. The insoluble corrosion products consist of mixed oxides of iron, chromium, and nickel, identical in structure with magnetite ($Fe_3O_4$) and exhibiting similar properties, including magnetic susceptibility. This corrosion product occurs as a fine black powder. A more complete discussion on materials in nuclear power plants has been presented elsewhere (*1*).

#### RADIOACTIVITY LEVELS

It was recognized that certain impurities entering the water either from corrosion or from feed water would become irradiated as they passed through the reactor section. Constituents present in the minutest quantities could become a radioactivity problem because of their high cross sections, that is, tantalum, cobalt, sodium, and manganese. These constituents show up in the general activity level of the water and of surfaces on which corrosion products adhere. Information was needed on the minimum impurities which could be maintained by purification. Consequently, considerable development work was done in experimental loops containing filters and ion exchange resins in by-pass purification streams. It was concluded that commercial, mixed-bed hydrogen-form cation and hydroxyl-form anion resins would perform satisfactorily for this application. Water with an electrical conductance of approximately 0.3 micromho/cm. could be maintained. The information thus obtained was used to size the purification system for the plant.

#### MECHANISMS AND VALVES

There are a number of mechanisms in the plant which are designed to close tolerance, and which depend on primary water as a lubricant for rubbing surfaces. It was considered important that suspended particles be prevented from entering these vital sections. Examples of important components are (1) the mechanisms which position the nuclear control rods to give power control, and (*2*) hydraulically operated valves. Consequently, the purification system was strategically located to supply clean water for these components (Figure 1).

#### FOULING OF HEAT TRANSFER SURFACES

The possibility of fouling of reactor heat transfer surfaces with corrosion products was recognized early in the program. Preliminary experiments with stainless steel loops indicated that even the small amount of corrosion products generated was sufficient to reduce heat transfer coefficients on heat exchange tubes. Concern over this problem was intensified, however, by the results of a so-called in-pile experiment performed on a zirconium-clad fuel section in an engineering reactor test.

This experiment was intended as a test of the behavior of the zirconium-clad fuel element under actual fuel performance conditions. The equipment used was a closed stainless steel loop in principle similar to the power plant already described in Figure 1, including the same type of water purification. A portion of the loop was exposed to the neutron flux of the reactor. This in-pile section contained a zirconium-clad fuel element. It contained sufficient fissionable material so that appreciable heat generation occurred. For purposes of comparison, a similar nonfunctioning fuel element was placed in the out-of-pile section of the same closed loop. The circulating-water conditions were 500° F. and 2,000 lb./sq.in. Except for short periods when the reactor was shut down, the loop was operated continuously for several months. During the first part of the program, oxygen and hydrogen, formed by radiation-induced dissociation of water, were vented through the pressurizer. During the latter part of the program. the gases were permitted to remain in the system.

At the end of the experiment, the loop was opened and both fuel elements were examined. The results were: (1) neither element showed corrosion of zirconium, (*2*) the surfaces of the in-pile or functioning fuel element were coated with copious amounts of stainless steel corrosion products commonly called "crud," and (3) the out-of-pile or nonfunctioning fuel element was comparatively clean. It was not clear from this test whether the fouling effect was due to heat flux alone or to nuclear radiation. Other experiments indicated that radiation was definitely a factor

(*2*). This phenomenon could not be permitted to occur in an actual plant. The consequences would be a decrease in heat transfer coefficient, obstruction of flow, and ultimately rupture of fuel elements as their temperature increased. Should this occur, fission products would leak into the primary coolant. Fission products are many times more radioactive than irradiated corrosion products, with the result that the whole plant could become sufficiently radioactive so as to be inaccessible.

Because of the serious nature of fouling, an extensive program was undertaken looking toward means of avoiding it. Conventional means of corrosion inhibition and prevention of fouling were considered. For the most part, these were inapplicable because of adverse effects of radiation on chemical additives. Two experimental approaches were stressed. Hydrogen was added to the water as a possible means of inhibiting corrosion, and high $p$H (10) water was tested (*2*) as a means of minimizing liberation of corrosion products to the water. By the time operation of the Idaho plant was started, it had been decided to add hydrogen to the water. The advantages of high $p$H water were not considered sufficiently established to be applied at the time. Work in this direction is continuing.

### Early Operating Results

During the first year of plant operation, the water to the primary loop (original fill and make-up) was highly purified, that is, demineralized and degassed. Hydrogen was maintained at a concentration of approximately 100 cc./kg. by periodic additions from cylinders. Operations during most of this period were devoted to matters other than chemistry technology. Except for one early run, the power conditions varied widely as dictated by engineering tests not associated with water chemistry. Figure 2 is an example of a typical water chemistry log obtained during most of the testing program, particularly during long runs when the plant was in a stable condition. It was usually observed (though not always) that deviations in the water chemistry were associated with plant start-up, particularly after a lengthy shutdown. The manifestations were:

a. The filter plugged rapidly, so that frequent backflushing (sometimes hourly) was necessary.

b. The concentration of insoluble corrosion products in the water (crud) increased sharply and then declined gradually as operation continued.

c. Conductivity and pH increased sharply, and then declined gradually as operation continued.

Data associated with these periods are given in Table 1.

The explanation for the unusual water chemistry at start-up will be discussed later.

### Chemical Phenomena Observed in the Plant

#### DISSOCIATION OF WATER, REVERSE FORMATION FROM $H_2$ AND $O_2$

Under the influence of nuclear radiation and in the absence of substantial amounts of free hydrogen, water dissociates partially into dissolved hydrogen and oxygen. Tests run on the plant showed that as the hydrogen was reduced to some 4-5 cc./kg., oxygen appeared in the water to the extent of about 0.05 p.p.m.

The reverse reaction also occurs. If oxygen or air is added to the plant containing excess hydrogen, the oxygen combines rapidly with the hydrogen. The reaction of hydrogen and oxygen occurs also with the power off because of the influence of residual gamma radiation from the fission products formed in the fuel.

#### REACTION OF HYDROGEN AND NITROGEN TO FORM AMMONIA

Under the influence of nuclear radiation, hydrogen and nitrogen in the primary water react to form ammonia. This reaction was demonstrated by the addition of nitrogen to the loop while the plant was operating with an excess of hydrogen. Although the rate of formation is high, the equilibrium lies on the side of nitrogen and hydrogen, that is, conversion of nitrogen to ammonia is of the order of 5%. In actual operation, however, the demineralizer removes the ammonia and synthesis continues until the nitrogen is depleted.

**Table 1.—Representative Water Data Obtained with $H_2$ at 100 cc./kg, Normal Filter and Demineralizer Operation**

| | Normal | Abnormal (start-up) |
|---|---|---|
| pH | 7.5–8.5 | 8.5–9.3 |
| Conductivity, micromhos/cm. | 0.3–1.5 | 3–7 |
| Crud, p.p.m. | 0.05–0.25 | 0.5–1.8 |
| Oxygen | (essentially undetectable by standard Winkler test) | |

#### REACTION OF NITROGEN AND OXYGEN TO FORM NITRIC ACID

In the absence of free hydrogen, nitrogen reacts with dissolved oxygen and water to form nitric acid as evidenced by a declining $p$H and the formation of nitrate ion.

### Simplification of Water Technology

Subsequent to the period of engineering testing, a program was undertaken to simplify the general scheme of water purification and control. Specifically the objectives were (1) elimination of feedwater deaeration, (2) elimination of filters, and (3) elimination of hydrogen addition. Ultimately a short test was performed without any purification, that is, filter and demineralizer by-passed.

#### USE OF NONDEAERATED FEED WATER

After preliminary tests, the condition of the make-up water was changed from deaerated to nondeaerated. Hydrogen was maintained in excess. With this type of operation, the oxygen from the air combines so rapidly with the hydrogen that it is not detectable. The nitrogen is converted to ammonia, so that the net result during continuous operation is the formation of ammonia with a resultant increase in $p$H. The ultimate concentration of ammonia is dependent upon the concentration of nitrogen (with hydrogen in great excess), the power level, water leakage rate, and the demineralizer flow rate.

From the chemical point of view, the use of nondeaerated water (in a hydrogenated system) is actually advantageous in that the resulting moderately alkaline condition probably minimizes fouling (*2, 3*). A radiation problem, however, develops as a result of the argon introduced with the air. Nuclear radiation produces radioactive argon-41 which increases the radioactivity level of the system.

#### ELIMINATION OF FILTER

The plant was operated for a long period without the hydraulic service filters with no adverse effect on the hydraulically operated valves. During this period, the crud concentration showed the same pattern as during filter operation, that is, the concentration increased during the relatively frequent plant start-ups probably as a result of hydraulic effects and the expansion as temperature is raised. It should be noted that a strainer capable of retaining particles larger than 80$\mu$ was used in place of the filter so that some protection was afforded the hydraulic valve mechanisms. In addition, the demineralizer performs as a filter when the regular filter is by-passed, but a smaller flow of

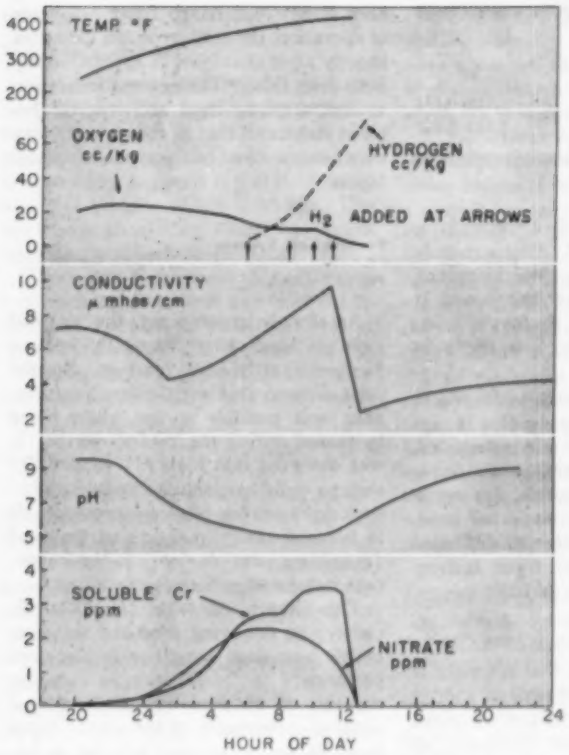


Fig. 3. Plant start-up with air in loop, water chemistry (low power).

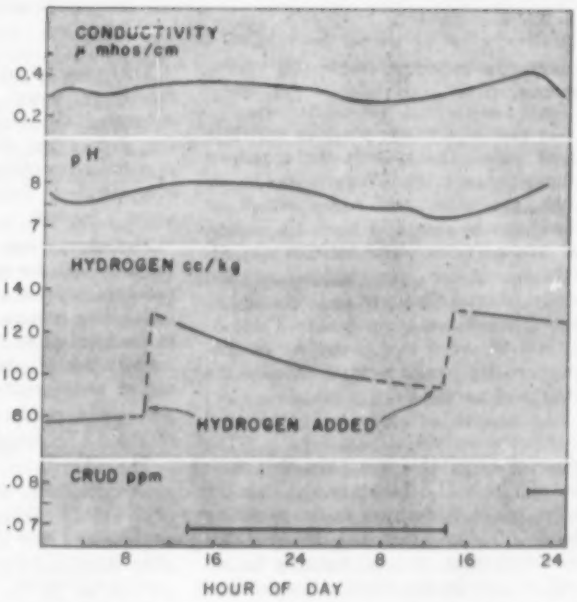


Fig. 2. Water chemistry, typical operating log. Temperature 450° F.; power 8 to 30% of full; filter and demineralizer in service.

water is filtered. The long-term effects of operating a plant with no filtration have not been evaluated.

#### OPERATION WITHOUT HYDROGEN ADDITION

The approach to the condition of "no hydrogen addition" was made stepwise. The hydrogen specification was first dropped from the original 100 cc./kg. to a nominal 25 cc./kg. It was concluded that a hydrogen concentration of 25 cc./kg. was adequate once steady-state conditions were established. Signs of difficulty were observed on those start-ups in which considerable air was trapped in the primary system. The indication was that the low level of hydrogen was not adequate for complete elimination of oxygen and the $p$H dropped below 7. A specific test on this phenomenon is described later.

#### EQUILIBRIUM HYDROGEN TEST

An attempt was made to permit the plant to reach a point of equilibrium hydrogen concentration whereby the hydrogen produced by corrosion would equal that lost by leakage and reaction with oxygen and nitrogen. The hydrogen concentration declined in about two weeks from an initial concentration of 30 to 2.5 cc./kg. Oxygen from water dissociation was detectable at hydrogen concentrations below 4 cc./kg.

#### PLANT START-UP WITH OXYGEN PRESENT IN LOOP

In connection with the same objective of eliminating the need for hydrogen addition, a test start-up was made with dissolved air already present in excess. Figure 3 illustrates the sequence of chemical events which occurred. The test was performed at low power. At the start, the $p$H and conductivity were high. Hydrogen was low (less than 3 cc./kg.), oxygen was approximately 25 cc./kg. (35 p.p.m.) and nitrogen 115 cc./kg. As the radiation-induced reactions took effect, the oxygen depleted the residual hydrogen, and reacted with the nitrogen to form nitric acid. The $p$H dropped from 9.5 to 5. The conductivity first declined as the hydroxyl ion was neutralized, and then increased with the formation of hydrogen ion. Nitrate concentration also increased, verifying the formation of nitric acid. It is interesting to note that soluble chromate increased. It may have come from certain chrome-plated surfaces, from the stainless steel walls, or from dissolution of suspended corrosion products.

When the $p$H reached a low level, hydrogen gas was added to the loop water. The result was a reduction of nitrate, chromate, and residual dissolved oxygen. The $p$H ultimately returned to the alkaline side. The soluble chromate was probably reduced to the insoluble chromic oxide.

The conditions which were observed during the early phases of plant operation can now be readily interpreted. It will be recalled that during start-up, it was observed that $p$H and conductivity usually increased. Air pockets probably were present during some of the start-ups. In the presence of 100 cc./kg. hydrogen, the oxygen was consumed in the formation of water. Ammonia was then formed with a resultant increase in $p$H and conductivity. Since the specification called for an operating level of hydrogen at 100 cc./kg., the reducing condition was readily maintained. Eventually most of the nitrogen was removed by virtue of removal of the ammonia by the demineralizer, with an accompanying decline in conductivity and $p$H.

### Performance of the Plant

#### CORROSION

Estimates based on crud concentrations in the water indicate that the corrosion rate is of the order of that established in pilot plant studies—about 10 mg./(sq.dm.)(month).

**Table A.**

| | Fe | Cr | Ni |
|---|---|---|---|
| 347 stainless | 1.00 | 0.25–0.275 | 0.122–0.174 |
| Crud samples | 1.00 | 0.04–0.143 | 0.143–0.157 |

### CORROSION PRODUCTS AND THEIR RADIOACTIVITY

In chemical terms, the loop water is quite pure. The bulk of the contained impurities are the insoluble oxides of iron, chromium, and nickel which at times can be seen as a black suspension of fine particles. The relative concentrations of the iron, chromium, and nickel in crud compared to 18-8 stainless steel composition are shown in Table A. It will be noted that chromium is proportionately lower in crud than in the source of metal.

As pointed out previously, the crud concentration varies considerably. The general experience has been that it is usually high (1.5-2.0 p.p.m.) at start-up, after which it declines to an operating level of 0.1-0.3 p.p.m. It is believed that the high value, or crud burst, is the result of a hydraulic effect when the flow is started. Crud is picked up from pockets and suspended in the stream. When flow is stabilized, the crud settles out again in low-velocity areas.

Although the impurities other than iron, chromium, and nickel are hardly detectable by chemical analysis, some of them become highly radioactive after exposure to nuclear radiation.

The predominant radioactive species fall into four general groups as listed in Table 2.

The very short-lived activity is a function of power level. Its magnitude determines the shielding requirements of the plant other than reactor core. It presents no problem at shutdown, however, since it decays to low levels in about a minute.

The short-lived activity is largely a function of the power level. It approaches a value of 0.3 microcuries/ml. (excluding argon) at 100% power. If air is excluded from the system, the argon activity is negligible; on the other hand, use of nondeaerated water as discussed previously, results in an argon activity of about 0.5 microcuries at 100% power.

The short-lived activity decays almost completely in about 48 hr. The practical significance is that the plant is accessible (1) for limited periods shortly after shutdown, (2) for almost unlimited periods at 48 hr. after shutdown, at which time only the long-lived activity remains. The practical significance of the long-lived activity is that actual handling of equipment, such as shop work, requires special procedures since the surfaces are coated with significant quantities of the long-lived radioactive corrosion products which represent some hazard on close handling.

Long-term experience indicates that the long-lived activity on the walls has been slowly increasing. After two years of operation, the activity in the loop area shortly after shutdown is approximately 50% long lived. The current indication is that the long-lived activity will become stabilized, that is, the rate of decay may become equal to the rate of accumulation.

**Table 2.—Radiochemistry of Coolant ***

| Nuclide | Half life | Specific activity | Source | Significance |
|---|---|---|---|---|
| $N^{16}$ | 7.3 sec. | 100$\mu$c/ml. | $O^{16}$ in $H_2O$ | establishes shielding requirements for operation, other than reactor core. |
| $N^{17}$ | 4.1 sec. | 800 neutrons/(cc.)(sec.) | $O^{17}$ in $H_2O$ | |
| $K^{42}$ | 7.7 min. | $5 \times 10^{-5}$ $\mu$c/ml. | ? | establishes accessibility shortly after shutdown ** |
| $A^{41}$ | 1.8 hr. | $4 \times 10^{-5}$ $\mu$c/ml. | air in $H_2O$ | |
| $F^{18}$ | 1.9 hr. | $4 \times 10^{-5}$ $\mu$c/ml. | ? | |
| $Mn^{56}$ | 2.6 hr. | $0.5 \times 10^{-5}$ $\mu$c/ml. | steel | |
| $Cu^{64}$ | 12.8 hr. | $3 \times 10^{-4}$ $\mu$c/ml. | 17–4PH steel | |
| $Na^{24}$ | 15 hr. | $10^{-5}$ $\mu$c/ml. | Na in $H_2O$ | |
| $W^{187}$ | 24 hr. | $3 \times 10^{-5}$ $\mu$c/ml. | Stellite | |
| $Fe^{59}$ | 45 days | $1.1 \times 10^{-5}$ $\mu$c/ml. | steel | defines precaution required for repairs*** |
| $Ta^{182}$ | 111 days | $0.6 \times 10^{-5}$ $\mu$c/ml. | steel | |
| $Co^{60}$ | 5.3 yr. | $2.5 \times 10^{-5}$ $\mu$c/ml. | steel | |

* The four groups of nuclides in the table are arbitrarily defined as very short-lived activity, short-lived, intermediate, and long-lived.

** The short-lived group, other than argon, approaches a total of 0.3$\mu$c/ml. at 100% power. The relative amounts of each vary as the previous power history. Argon activity is dependent upon power level and air accumulation.

*** Varies as the crud concentration.

### Purification System

#### FILTER

As already pointed out, the sintered stainless steel filter frequently became plugged shortly after start-up. Special tests showed that satisfactory performance was possible if the filters were by-passed during the heat-up period. It was observed that high $p$H (about 10) such as could be produced by lithium hydroxide improves filter performance. It is believed that the nature of the crud (possible oxidation state) is the important factor rather than the quantity.

The filter is effective (60-80% efficiency) in removing crud and its associated long-lived activity. It therefore performs a useful function in reducing the rate of accumulation of long-lived activity on surfaces of the plant. Since most of the short-lived activity is apparently soluble and since the short-lived activity is predominant, the filter is less effective for the purpose of minimizing the total water activity (efficiency of the order of 15-40% other than argon) during operation.

#### DEMINERALIZER

The performance of the resin itself was satisfactory as measured in terms of influent/effluent ratios of conductivity and radioactivity. Effluent conductivities of less than 0.1 micromho/cm. were readily maintained for influent conductivities as high as 10 micromho/cm. In a 1,100-hr. test with the filter by-passed (so that the resin was also functioning as a filter), the removal of short-lived activity (largely solubles and excluding argon) was 99%, and the removal of long-lived activity (largely insolubles) was 95%. At the termination of the test, the demineralizer capacity was only one third spent. General experience has been that ammonia removal constitutes the largest load on the demineralizer. The exhausted resin is discarded rather than regenerated.

Performance in terms of primary loop water activity presents a somewhat different picture. A series of tests at different by-pass flow rates through the resin indicated that the short-lived activity in the loop water is not affected by the demineralizer. This is as expected in that the short-lived activity decays faster than it is removed by the demineralizer.

## FOULING

### Heat Transfer Surfaces

Fuel elements have remained relatively clean. The explanation probably is that the plant has been operated (except for short periods) with excess hydrogen (zero oxygen) and at moderately high *p*H because of the ammonia. Under these conditions fouling is maintained at a minimum (*4*).

There has been some deposition on heat exchanger surfaces as evidenced by the slow increase in radiation level of these components. In the case of the pressurizer heat exchanger, the increase has been large enough to require addition of lead shielding.

### Mechanisms and Valves

Some nominal difficulties with valves have been encountered, but these can not be associated unequivocally with crud.

The reactor control rod mechanisms have shown serious malfunctions on only one occasion following a period of operation in which both the filter and the demineralizer were by-passed. The difficulty was encountered after the start-up test with dissolved oxygen in the plant (described above). There was an indication that crud alone on the mechanisms was causing trouble. It is also known from other experience that dissolved oxygen causes temporary malfunction (return to normal occurs slowly after removal of oxygen from water) of the rod mechanisms. In this particular case, it is likely that the malfunction was caused by a combination effect of both crud and oxygen.

### Comparison with Conventional Power Plant Water

Some similarities and differences between the water technology for this type of nuclear plant and that for conventional steam power plants are considered here.

## SECONDARY OR STEAM-GENERATING SYSTEM

The secondary system, comprising steam generators, turbines, condensers, and feed-water systems, is basically the same as for conventional plants. The fundamental problems of fouling, corrosion, and carry-over are still present. The usual considerations govern selection and control of feed-water preparation, boiler water treatment, and steam condensate system corrosion inhibitors.

Some differences in materials and water technology are introduced, however, because the boiler design is basically different. It involves passage of primary water through many small diameter, thin-walled tubes surrounded by boiler water. This means that

1. **Tube failure due to overheating is impossible. Maintenance of clean heat transfer surfaces is essential, however, from the standpoint of efficiency and avoidance of localized corrosion effects due to deposits.**
2. **Any leakage through the tubes or tube sheets will be from the primary system into the boilers because of the pressure differential, with a resultant introduction of radioactive water into the secondary system. This type of contamination can be readily detected by instruments, and a fairly large leak is required before serious contamination is experienced. However, it is essential that the design assure high integrity of the tubes and tube sheets.**
3. **Careful control of corrosion and oxygen pitting is required to protect the thin-walled tubes. In existing plants that use austenitic stainless steel tubes, it is also considered necessary to maintain extremely low chloride ion (and probably low dissolved oxygen) concentrations in the primary and secondary waters to avoid stress-corrosion cracking.**

## PRIMARY COOLANT SYSTEM

High purity make-up water for the primary plant is prepared by methods familiar to operators of central stations —demineralization and evaporation. In existing plants, single bed cation-anion exchanger combinations have been used, at least as a final step. The method of pretreating the demineralizer feed depends on the quality of the raw water available.

Power plant chemists are acquainted with analytical methods for most of the constituents which normally must be measured in the primary water, that is, dissolved oxygen, *p*H. and conductivity. A special, high pressure conductivity cell has been used to permit continuous monitoring of a cooled stream of primary water which returns to the primary system. Other common determinations such as ammonia, hydrazine, and iron may be required at times. Several constituents, not commonly measured in other water applications, are dissolved hydrogen and dissolved nitrogen. These are required because of the use of hydrogen as an additive, and the radiation-induced reactions previously discussed. Measurement of insoluble corrosion product concentrations is also required. This has been done by filtering a known quantity of a cooled, by-pass stream of primary water and measuring the weight increase of the filter.

The major innovations in water technology result, quite naturally, from the presence of nuclear radiation. These include the following:

1. **Reactor radiation will either decompose most materials in the water or cause them to become radioactive, thereby severely limiting the use of additives for corrosion control or other purposes.**
2. **Radiation may increase the tendency of fuel elements to foul with system corrosion products.**
3. **Gamma radiation will cause dissolved hydrogen and oxygen to recombine, thereby providing a "built-in" oxygen scavenger. This can be a two-edged sword, however, because nuclear radiation will produce oxygen by dissociation if the hydrogen concentration is too low.**
4. **Radiation-induced reactions of dissolved gases may alter radically the *p*H of the primary water, producing corrosion and fouling effects.**
5. **Radioactivity induced in the primary water and transferred to pipe walls hinders inspection required to evaluate results with respect to fouling and corrosion.**
6. **Radioactivity monitoring of the water and some radiochemical analyses are required.**
7. **Means for disposal of radioactive water, ion exchange resins, and backflush water from filters or strainers, must be provided.**
8. **Radioactive samples must be taken and analyzed.**


### Acknowledgments

The information described in this paper is the result of work carried out under prime contract to the U. S. A.E.C. The authors have drawn freely from the work and experience of many engineers and scientists at the Bettis Laboratories of Westinghouse Electric Corporation. Discussions with M. H. Feldman were of particular value in connection with the description of the radiochemical and radiation chemistry of primary coolant.


### Literature Cited


1. Wroughton, D. M., and D. J. De Paul, "Structural Materials for Use in the Pressurized Water Reactor." *Am. Inst. Mining Metallurgical Engrs.*, New York, I.M.D. Special Report Series No. 2 Nuclear Metallurgy (1956).
2. Rockwell, T., and P. Cohen. "Pressurized Water Reactor (P.W.R.) Water Chemistry." *Proc. International Conference on Peaceful Uses of Atomic Energy*, **9**, page 423, United Nations, New York, (1956).
3. Wroughton, D. M., J. M. Seaman, and H. P. Beaghly, "Water Technology for Primary Systems in Water-Cooled Power Reactors." Presented at the E.J.C. Nuclear Congress, Cleveland, Ohio (December 12-16, 1955).
4. Datsko, S. C., "Metal Transport in Liquid Water Systems," *Trans. Am. Soc. Mech. Engrs.*, **78**, No. 6, page 1213 (August, 1956). Diamond Jubilee annual meeting, Chicago, Ill. (See also references 2 and 3.)

# DIRECT MAINTENANCE
# Fuel Processing Plant is Practical

*D. G. Reid and K. K. Kennedy* | Phillips Petroleum Company, Idaho Falls, Idaho

Processing facilities for spent reactor fuel can be of the direct maintenance type, requiring repairs by personnel entering the process area and in physical contact with the equipment, or the remote maintenance type, which uses manipulators for handling the equipment.

The remote type of plant is of greater complexity, requires greater investment, and has more specialized equipment, but once was felt to be more reliable for meeting production commitments because of the inherently shorter time requirement for equipment failure repairs. Experience has shown, however, that equipment decontamination in a direct maintenance plant is possible in a reasonable length of time, permitting an average of 300 operating days per year.

A processing facility designed simply to remove nuclear poisons might be considerably different from one designed to accomplish complete decontamination of the fuel. Reactors requiring only nuclear "poison" removal are, however, only in the development stage; thus, the Idaho Chemical Processing Plant (ICPP) (the example upon which this paper is based) is at present producing a completely decontaminated product from all types of clad fuel elements.

Various aspects of ICPP facilities and operations pertaining to direct maintenance are described as follows:

#### Feed Transportation

Fuel elements are transported between the reactors, storage basin, and process building in shielded casks carried by a conventional straddle (lumber) carrier, shown in Figure 1. Casks have a movable section at the bottom to permit dropping the fuel elements directly into pipes leading to the dissolving vessels.

#### Process Layout

The fuel process building itself is largely below grade level, with process units divided into several cells. The concrete cell walls vary from 5 feet thick, for radiation shielding at the head of the process, to 2 feet thick for structural strength in the final stages.

In the direct maintenance plant, the cell space can be used effectively at all elevations (Figure 2), whereas in remote maintenance areas, access generally is from above, precluding more than one tier of equipment per cell.

All pipes through cell walls, removable concrete hatch plugs and entryways to radioactive areas are built with one or more offsets or bends to prevent radiation beams from leaving the cells.

#### Materials of Construction

Microgram quantities of fission products adhering to porous or rough vessel walls can produce (from adhered contaminant) radiation levels too high to permit personnel access to the vicinity. Original surfaces of the processing equipment must be smooth and corrosion must be kept as low as possible.

Welded vessels and piping are preferred. In many cases non-welded tubing and compression fittings have been replaced with welded pipe because even extremely slight leakage through the tube fittings results in external contamination and, in some cases, small product losses.

Concrete, being quite porous, is impossible to decontaminate; therefore cell floors and portions of the walls are lined with stainless steel sheeting (Figure 3). The remainder of the walls and ceilings are coated with a chemically resistant paint if radiation exposure is not expected to exceed about $10^{10}$ roentgens during the service life of the cell. Floors of areas where personnel may handle radioactive solution are covered with asphalt tile.

#### Mechanical Equipment

Moving parts of any kind are avoided wherever possible. Where unavoidable, provisions are incorporated for lubrication, flushing of gear boxes and detection of impending failure from remote locations.

Special long-handled tools and radiation shields are provided for removing and transporting spent stainless steel vacuum filter cartridges to a contaminated burial area.

It has been found preferable to mix liquids by air sparging. Earlier installed mechanical mixers have been replaced because of difficulties with tightness of seals.

Fluid movement is accomplished by gravity flow, blow cases, steam jet syphons or diaphragm pumps in which the diaphragm in contact with the highly radioactive fluid of the first extraction cycle (which removes the bulk of the fission products) is located within a shielded cubicle adjacent to the process cell and is energized by a fluid leg from the primary diaphragm located in an unshielded area. In locations beyond the first extraction cycle, a standard diaphragm pump located within a lightly shielded cubicle is satisfactory.

#### Criticality

For handling high concentrations of uranium, criticality control is by vessel sizing and location (Figure 4). For example, product storage vessels are fabricated from lengths of pipe of such diameter that they are in themselves nuclearly safe, arranged sufficiently far apart so that interaction between individual pipes or assemblies is negligible. Floors slope to a small diameter sump having an alarm to indicate liquid presence.

#### Decontamination

Vessels and piping are all fabricated and installed with a minimum of pockets and crevices where solution can be held up out of reach of the normal flow paths. Equipment, wherever possible, is totally enclosed and is vented through a tight system under slight vacuum through a Fiberglas filter and eventually to atmosphere by a 250-foot stack.

Special decontamination equipment includes a spray system in each cell to wash down the outside of the equipment with water. Internal sprays in each highly radioactive vessel are fed by a steam jet which recirculates solutions from the same vessel.

In general, batch evaporators that are alternately heated and cooled are the most difficult to decontaminate, while vessels operating at a constant liquid level at room temperature are relatively simple to clean.

Pieces of equipment which may require frequent maintenance are usually shielded from the surrounding highly radioactive equipment. This has permitted personnel to enter some process areas after only simple decontamination measures; in some cases access is permitted during operation.

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Condensed from a paper, "Design Philosophy of a Direct Maintenance Radioactive Chemical Plant," presented at First EJC Nuclear Congress.

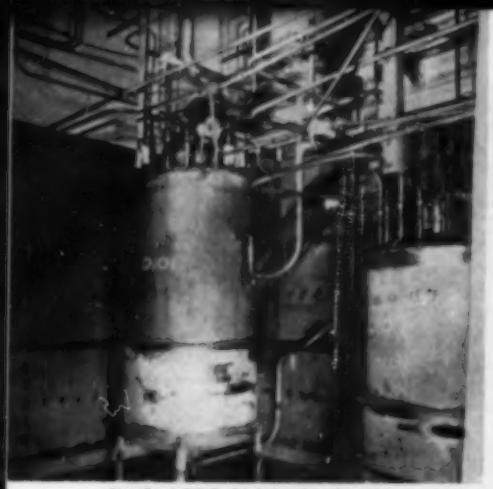


Fig. 3. I.C.P.P. high level radioactive processing equipment showing complexity of piping, stainless steel floor, and 10-foot high wainscoting.

Fig. 1. Conventional commercial straddle carrier removing an 11-ton carrier containing used reactor fuel elements from the Material Testing Reactor en route to the Idaho Chemical Processing Plant Reactor Fuel Storage.

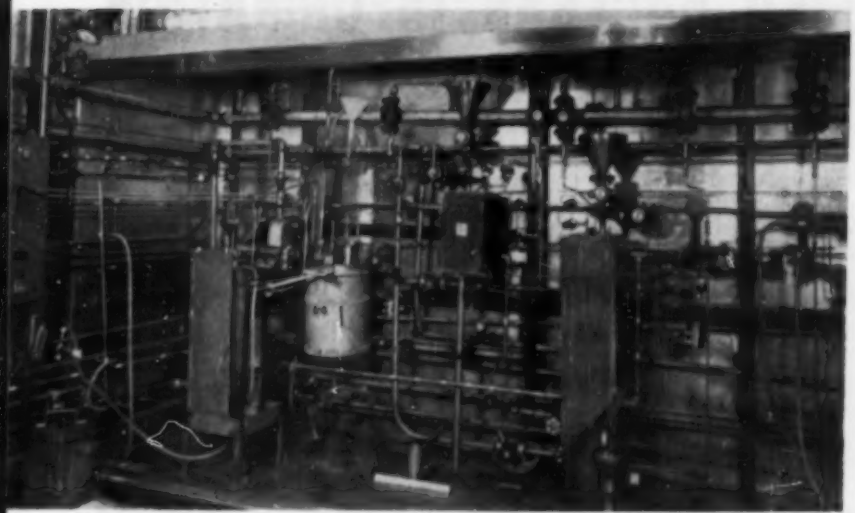


Fig. 5. Cation exchange, $U^{235}$ isolation process. The uranium product catch tank is on the left, the waste catch tank in the center, and the ion exchange resin columns are on the right.

Fig. 4. Model of processing cell showing geometrically safe equipment for criticality control (tubes) vs. two conventional tanks.

Fig. 2. Model of Idaho Chemical Processing Plant feed preparation equipment showing the multi-level installation of processing equipment possible in a direct maintenance plant.

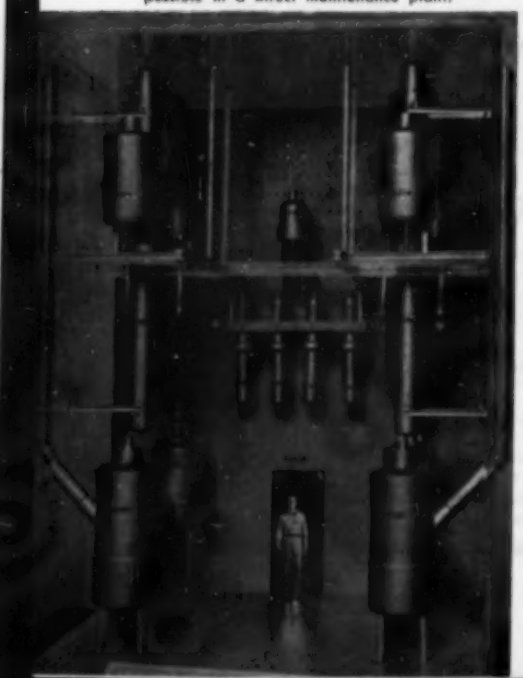


Fig. 6. A portion of the feed preparation instrumentation used in the process control center of the Idaho Chemical Processing Plant. Recording instruments (left) indicate operating variables such as densities and temperatures. Valves and switches on both sides control remotely the radioactive process streams involved in recovery of unfissioned $U^{235}$ from spent reactor fuel elements.

**Within the past few months, a large-scale effort on the part of AEC has resulted in the sudden review for release or reclassification of more than 30,000 reports on varied nuclear and related subjects which had been reposing silently in file cabinets, hidden away from general access.**

**Now that the AEC is engaged in such release of information, with more expected to be exhumed monthly, *CEP* is attempting herewith to inform its readers as to the nature of this material, how access to it may be had, how more of it may come into being, and the procedures that may be followed in preventing any comparable stockpiling of large quantities of documents in the future.**

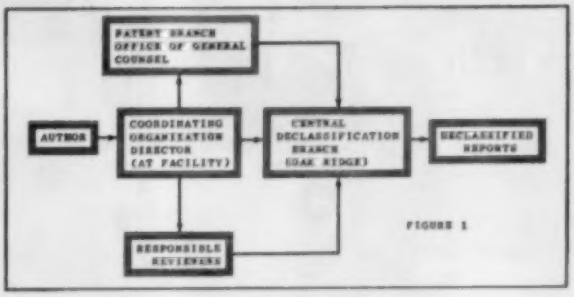


FIGURE 1

# UNCLASSIFIED NUCLEAR INFORMATION

In mid-1955, a team of 35 "responsible reviewers"—each a competent scientist—entered into a "crash program" at the Oak Ridge Operations Office (where a depository of all nuclear documents exists). By March of this year, some 30,773 classified reports had been reviewed by the team. Of these, 10,916 were declassified, but only about 7,500 have been published as having high technical value and general interest (issued as full size copies) or as having high technical value but only limited technical interest (issued on microcards). The balance, roughly 3,400, were regarded as obsolete, superseded, or no longer of use for other reasons. These, however, are available on request as photostatic copies. About 8,574 reports were downgraded to "confidential" status and 11,283 were left "secret" as having some relationship to the defense program.

This "crash program" was only a special project within the general program for continuous review of all currently-produced technical reports carried on by the Commission. It is understood also that the remaining backlog of classified reports will be re-screened periodically as new Declassification Guides are adopted.

### Present System Evolved Slowly

During the War, weapons use of nuclear energy was of paramount importance, and strategic reasons dictated the closest kind of security control over this new branch of science and technology.

The Atomic Energy Act of 1946 established the Atomic Energy Commis-

(*Continued on page* 80)

**Table 1.—DEPOSITORY LIBRARIES**

*California*
Berkeley, U. of Calif.
Los Angeles, U. of Calif.
Menlo Park, Stanford Res. Inst.

*Colorado*
Denver, Denver Pub. Library

*Connecticut*
New Haven, Yale U.

*District of Columbia*
Library of Congress

*Florida*
Gainesville, U. of Florida

*Georgia*
Atlanta, Ga. Inst. of Tech.

*Illinois*
Chicago, John Crerar Library
Chicago, U. of Chicago
Urbana, U. of Ill.

*Indiana*
Lafayette, Purdue U.

*Iowa*
Ames, Iowa State College

*Kentucky*
Lexington, U. of Kentucky

*Louisiana*
Baton Rouge, Louisiana State U.

*Massachusetts*
Cambridge, Harvard U.
Cambridge, M.I.T.

*Michigan*
Ann Arbor, U. of Michigan
Detroit, Detroit Pub. Library

*Minnesota*
Minneapolis, U. of Minnesota

*Missouri*
Kansas City, Linda Hall Library
St. Louis, Washington U.

*New Jersey*
Princeton, Princeton U.

*New Mexico*
Albuquerque, U. of New Mexico

*New York*
Buffalo, Lockwood Mem. Library
Ithaca, Cornell U.
New York, Atomic Indust. Forum
New York, Columbia U.
New York, N. Y. Pub. Library
Troy, Rensselaer Polytech. Inst.

*North Carolina*
Durham, Duke U.
Raleigh, No. Car. State College

*Ohio*
Cincinnati, U. of Cincinnati
Cleveland, Cleveland Pub. Libr.
Columbus, Ohio State U.
Toledo, U. of Toledo

*Oklahoma*
Stillwater, Oklahoma A. & M.

*Oregon*
Corvallis, Ore. State College

*Pennsylvania*
Philadelphia, U. of Pennsylvania
Pittsburgh, Carnegie Library
University Park, Penn. State U.

*Tennessee*
Knoxville, U. of Tennessee
Nashville, Joint Universities Libr.

*Texas*
Austin, U. of Texas

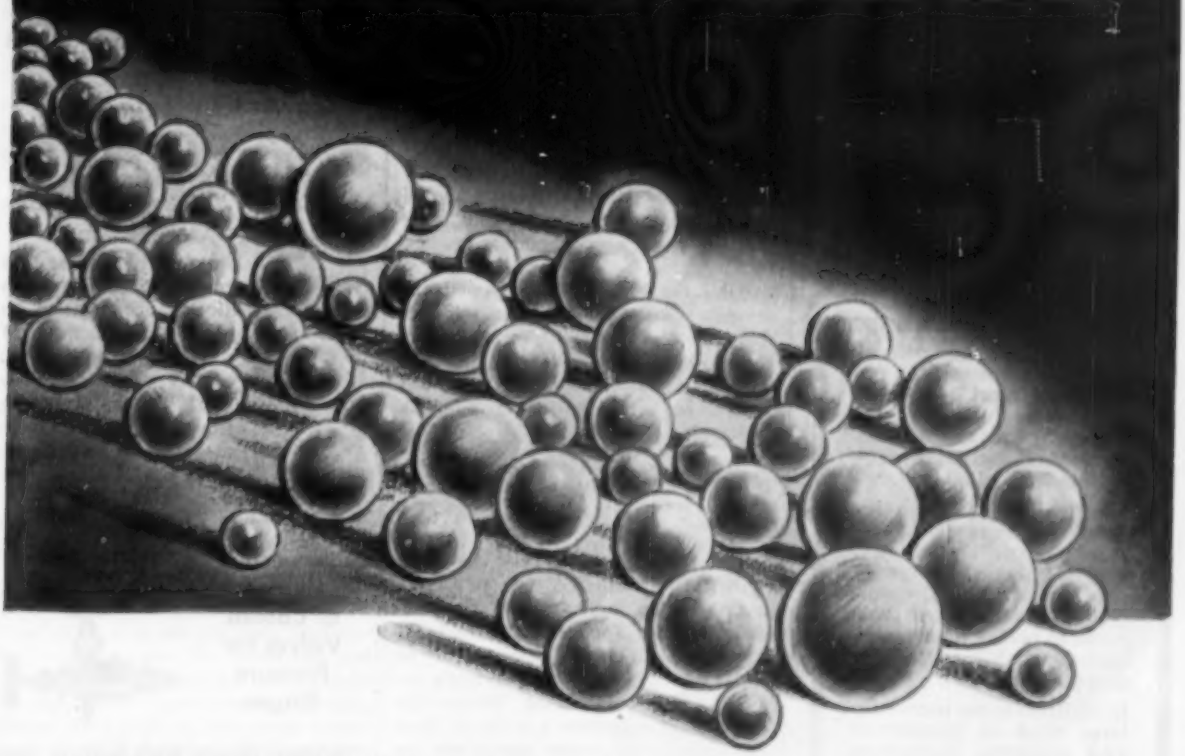
*Utah*
Salt Lake City, U. of Utah

*Washington*
Seattle, U. of Washington

*Wisconsin*
Madison, U. of Wisconsin

# Ceramic Balls

## FOR CATALYST SUPPORT, FOR PYROLYTIC REACTIONS AND AS MOVING BED HEAT TRANSFER MEDIA



As a heat transfer and catalyst support medium in various platinum catalyzed refining operations, "U.S." Ceramic Balls are proving unusually effective. They are being widely used for desulfurization processes and thermal cracking in fixed position or moving bed heaters.

"U.S." Ceramic Balls possess heat-shock resistance, superior thermal conductivity and high specific heat. Resistance to crushing is excellent, permitting successful operation with bed depths exceeding 50 feet. The material is thoroughly vitrified and is particularly recommended for its proven resistance to erosion and abrasion. Their complete chemical inertness makes them exceptionally useful where highly sensitive catalysts are involved.

The smooth surface and spherical shape of "U.S." Ceramic Balls have proven more efficient than irregularly sized and shaped heat transfer elements.

"U.S." Balls are available in two grades, both offering lower cost per unit volume: "Standard Body 57," and "Ceratherm-550" where unusual thermal-shock and heat resistance are required.

All sizes are available from ¼" O.D. to 3" O.D.

*Chemical Ceramics Division*

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## Basic to Dependable Lab Ware-VITREOSIL

**The most exacting needs of laboratories throughout the world are most eminently and successfully met by *Vitreosil* ware (pure fused silica) produced to the highest standards of quality.**

**Chemical purity, high resistance to heat shock, unusual electrical resistivity, best ultra-violet transmission (in transparent quality) and low initial cost compared to platinum are some features of *Vitreosil* fused quartz.**

**In addition to our unusually large stock of transparent and opaque, including glazed and unglazed crucibles, evaporating dishes, beakers, tubing and rods in all diameters and sizes, we offer prompt fabrication of special items.**

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FUSED QUARTZ CO., INC.
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Company_____

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## NUCLEAR INFORMATION

*(Continued from page 78a)*

sion, a group of five civilians to be appointed by the President with the consent of the Senate. Later in that same year, General Groves appointed a Committee of Senior Responsible Reviewers. This group, composed of eminent scientists in the nuclear field, act in an advisory capacity to the Commission on matters of classification. Final authority to remove categories of information from classified status rests with the Commission itself. The same principle applies to coordination of our classification policy with those of the United Kingdom and Canada.

Until the Atomic Energy Act of 1946 was amended in 1954, the pattern for the dissemination of nuclear information to industry was first through contractor personnel and then also through special study teams. The work of the latter consisted mostly of feasibility studies, etc.

After the 1954 Act was passed, the present system (to be described with diagrams illustrating the various group relationships) was put into action. In 1956 declassification activity was heightened by institution of the Oak Ridge "crash program."

### How Present Declassification System Works

The accompanying diagram (Figure 1) illustrates the path generally taken by a report from the time it is submitted by its author to its final declassification. The detour through the patent branch is to ensure that no patentable material is inadvertently released. The box labeled "Responsible Reviewers" represents a group of about 100 experts in various specialized nuclear fields. They act as advisors in borderline cases where there is considerable doubt whether a report should be classified or not.

In cases where there is very little doubt that a report should be declassified immediately, this is often done directly by the Coordinating Organization Director at the facility, or by the Central Declassification Branch at Oak Ridge following action by the Coordinating Organization Director.

Much of the information developed in basic research in physics, mathematics and chemistry at universities and colleges is today not classified in any way, but is released immediately for general consumption.

### Declassification Guides

All declassification is carried out on the basis of official Declassification

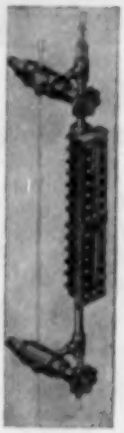
*(Continued on page 81)*


***How to Solve Problems of ACCURATE GAGING***

*of levels and pressures when liquids are*

***COLD and SLOW or HOT and FAST***

**Whether you handle liquids whose flow is "slow as cold molasses," or which boil and surge so they're hard to gage, Jerguson can solve your problems of accurate liquid level and pressure gaging.**



***Jerguson Heated or Cooled Gages***

**Specially designed to carry a circulating medium . . . heated to speed up the flow of slow, cold liquids . . . cooled to slow down boiling or surging liquids. Give you accurate liquid level readings, without tracing.**

***Jerguson Heated or Cooled Valves for Pressure Gages***

**Jacketed design with built-in tracing. Cold, heavy liquids flow so you get accurate pressure readings. Special design reduces threaded connections; combines unions, nipples, etc. in one compact unit. Ideal for cold services, waxes and other heavy materials.**

**Jerguson Gages and Valves now available with Electric Heating. Ask for special details.**

***Write for Data Units: #237 on Heat-Cooled Gages; #252 on Valves for Pressure Gages, etc.***

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*Gages and Valves for the Observation of Liquids and Levels*

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**100 Fellsway, Somerville 45, Mass.**
*Offices in Major Cities*
Jerguson Tress Gage & Valve Co., Ltd., London, Eng.
Pétrole Service, Paris, France

## NUCLEAR INFORMATION

(*Continued from page 80*)

Guides (themselves classified) issued by the Commission. These are kept up to date by continual revision and by coordination with the corresponding United Kingdom and Canadian guides.

#### How to Get Unclassified Documents

Forty-nine depository libraries (see Table 1.) have been established throughout the country to provide reference and photoduplication services covering their collections of unclassified nuclear energy reports, special publications and bibliographies. All of these libraries do not have complete collections of all AEC unclassified documents, but copies may be obtained on request.

#### BULLETINS AND ABSTRACTS

The "Report Announcement Bulletin; Unclassified Reports For Civilian Applications," arranged according to subject categories, is now being issued by the Technical Information Extension, Oak Ridge, Tennessee. All reports announced in this bulletin are available from: Office of Technical Services, Department of Commerce, Washington 25, D. C. The listed reports are described fully in Nuclear Science Abstracts available from the U. S. Government Printing Office, Washington 25, D. C.

#### SUMMARIES AND COMPILATIONS

In addition to the published unclassified reports, some 200 summaries and compilations are being sold, chiefly through the Government Printing Office. Best guide to this mass of material is "Unclassified Bibliographies of Interest to the Atomic Energy Program" (TID 3043) on sale from the Office of Technical Services, Department of Commerce—price, 35 cents.

#### Special AEC Publishing Program

Of special interest to the engineer is a publishing program now being carried out by the Technical Information Service of the AEC. An attempt is being made to compile an up-to-date summary of the nuclear art. This is expected to be published in separate volumes, each written by a noted authority and each concerned with some specialized aspect of the program. Subjects to be treated include radioactive waste disposal, uranium production, chemical separation, etc. These books are to be issued in two editions, one classified and the other unclassified. The classified edition will, of course, be available only to holders of access permits.

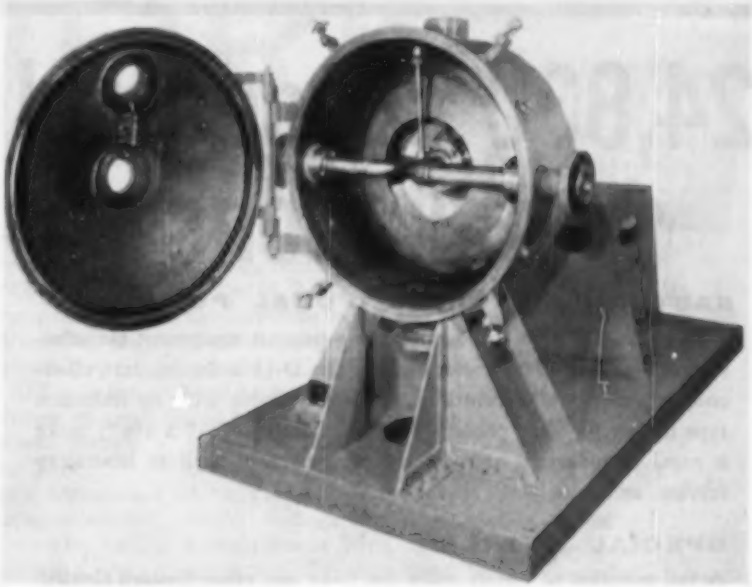

# DEFOAMING

**IS ONE OF THE EFFECTIVE AND ECONOMICAL USES OF THE**

# Versator®

**THIS MULTI-PURPOSE PROCESS UNIT IS NOW WIDELY USED FOR *SIMULTANEOUSLY:***

**Defoaming and homogenizing adhesive and latex formulations.**
**Defoaming and dispersing detergent slurries.**
**Deaerating and dispersing resins in plasticizers.**
**Homogenizing and dehydrating a hot gum-resin mix.**
**Dispersing soaps and additives in oils, and**
**Deaerating and dehydrating greases and oils.**



**CHARACTERISTICS:**

**For continuous or batch operation, the processing rate is 5 to 90 g.p.m. according to viscosity.**

**The viscosity range is from hot water to hot chewing gum.**

**It is safe for heat-sensitive materials.**

**CONSTRUCTION**—**carbon or stainless steel or in combination. It has only one principal moving part with large clearance; hence maintenance costs are negligible.**

***Versators are easy to clean.***

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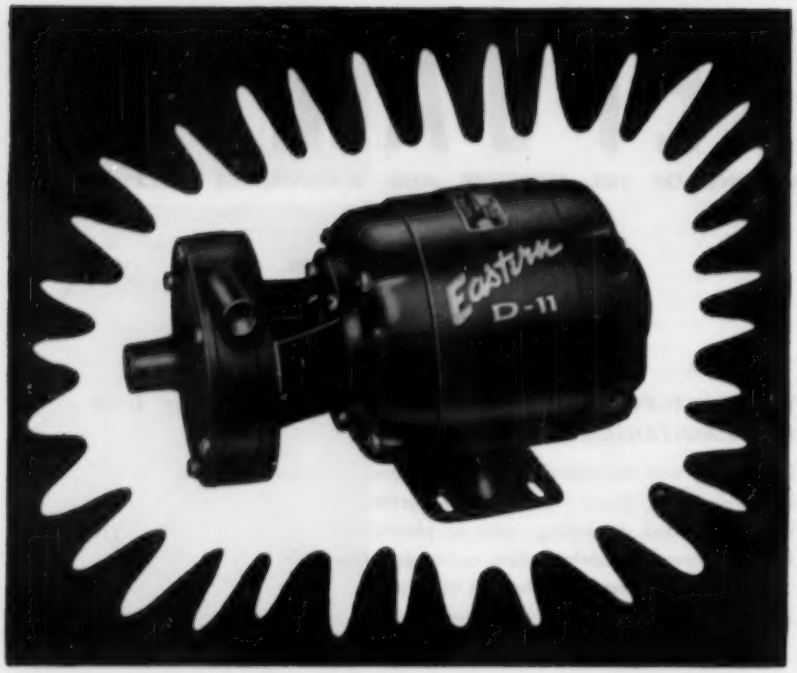
**THE CORNELL MACHINE COMPANY**
**99 Wall Street, New York 5, N. Y.**




# 24,830 successful installations!

**EASTERN D-11 CENTRIFUGAL PUMP**

Why is the D-11 so successful among original equipment manufacturers? *Size and weight* make it ideal. The D-11 is the smallest, close-coupled, single-stage centrifugal pump available with an induction type motor. Eighteen pounds of compact design (9¾" x 4⅝") make it excel in industrial and process equipment, as well as laboratory service, and pilot plant operations.

**SPECIAL METALS**

A full selection of metals make the D-11 and other Eastern Centrifugal Pumps versatile performers. Available in 18-8 Type 303 and Type 316 Stainless Steel, Monel, Hastelloy "C", Cast Iron and Bronze, Eastern Pumps range from ⅛th to ¾ H.P. with capacities up to 70 G.P.M., pressures to 65 P.S.I.

*For complete specifications on all Eastern Centrifugal Pumps, request Bulletin 120-A*

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100 Skiff St., Hamden 14, Conn.

RESEARCH NEWS

## NEW FLUIDS ENGINEERING LABORATORY DEDICATED BY FISCHER AND PORTER

**The late Allan P. Colburn honored in ceremony at Hatboro, Pa.**

The recently dedicated "Allan P. Colburn Memorial Flow Laboratory" at the main Fischer and Porter plant in Hatboro, Pa., is said to be one of the most completely equipped hydraulic test facilities in this country. It has been specifically designed for the calibration of flowmeters measuring hazardous or volatile fluids.

Calibration stands are accurate to within ±0.1% of absolute flow rate and presently provide a range from 100 lb./hr. to 125,000 lb./hr. of liquid hydrocarbons. The facility is equipped to conduct calibrations on both a production and a research basis.

R. L. Pigford, U. of Del., speaking at the dedication of Fischer & Porter's new Allan P. Colburn Memorial Flow Laboratory, Hatboro, Pa.

Among the speakers at the dedication ceremonies were Kermit Fischer, president of Fischer and Porter Co.; Samuel E. Pond, Pratt and Whitney Aircraft; and R. L. Pigford, chairman of the Department of Chemical Engineering, University of Delaware.

---

**A new company, Tryon, Inc., has been formed to undertake industrial research, development and manufacture on its own account or on a contract basis** in the fields of mechanical and chemical processes including heat transfer, combustion, fluid mechanics, corrosion, and materials of construction. □

**The Headquarters and Applications Laboratories of the newly-formed Polymer Chemicals Division of W. R. Grace & Co. is being located in Clifton, N. J.,** in a building recently purchased for that purpose. Selection of the Clifton site closely followed the start of work on the new Division's Grex polyolefin plant at Baton Rouge, La. □

# Buyers of Any Process Equipment Reap Benefits from M. W. Kellogg's

# COMMITTEE WORK

ANOTHER PLUS IN KELLOGG'S
BUILT-IN ENGINEER

As a leader in the design and fabrication of petroleum and petrochemical process equipment, The M. W. Kellogg Company assumes many extra curricular responsibilities which eventually benefit not only its customers but the process industries in general. One of these responsibilities is Kellogg's participation in technical committees of professional societies and associations, particularly at subcommittee working levels.

At present, M. W. Kellogg's engineers, metallurgists and others give a considerable part of their time to over seventy such activities . . . ranging from boiler and pressure piping codes to welding practices and radiographic testing techniques. Many of today's accepted design concepts were introduced to the engineering profession by Kellogg committee men.

The M. W. Kellogg Company is privileged to contribute increasingly to the important work of technical and engineering societies, associations, and related groups. The practical application of the knowledge imparted and gained is another plus which goes into Kellogg's "built-in engineer" approach to process equipment design and fabrication. A typical example is a paper prepared by M. W. Kellogg engineers, "Collection and Correlation of High Temperature Hydrogen Sulfide Corrosion Data," and presented at a recent meeting of the National Association of Corrosion Engineers. *Write for your copy.*

*Fabricated Products Division*

THE M. W. KELLOGG COMPANY, 711 THIRD AVENUE, NEW YORK 17, N.Y.

A SUBSIDIARY OF PULLMAN INCORPORATED

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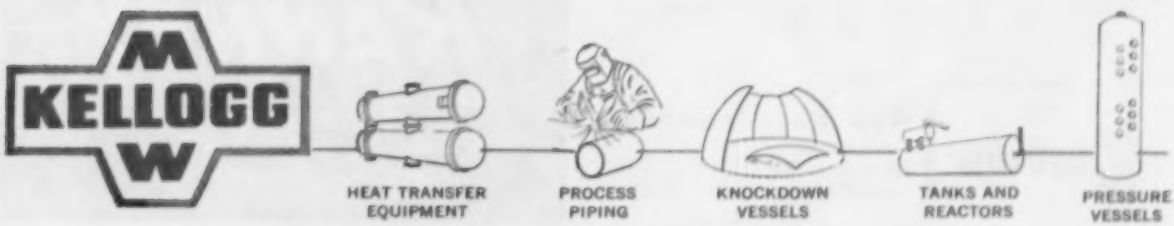


## Need Adjustable-Constant Flow Rates?

**DON'T Build a System . . .**

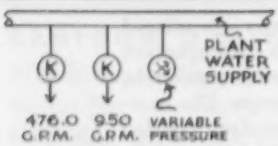
*Install a* **Kates***

* KATES Direct-Acting Flow Rate Regulators are complete in themselves, requiring no outside connections except inlet/outlet piping; for light slurries, clear liquids, and many suspensions; hold constant flow despite 125-psi jumps or drops in inlet-to-outlet pressure.

Economy may not be your principal reason for selecting a Kates regulator, but added to the single-unit compactness and no-hunt, no-lag features it is certainly a valued extra. And you will save on maintenance, too. Kates regulators are designed to eliminate wire-drawing, and the only packing is on the infrequently-used dial stem.

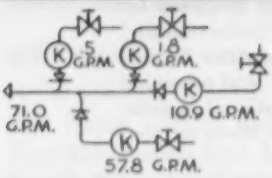
Write us for more details on the unique operating principles and practical design features of Kates flow rate regulators. But first, here are some of the problems that Kates has solved for others — *economically*.

**PROCESS WATER CONTROL**



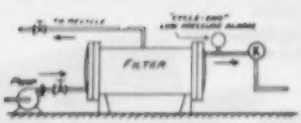

Pressure of most plant water fluctuates badly — whether it comes from city mains or in-plant pumps. If you need selected-constant flow, from 0.02 to 550 GPM, DON'T build a system. Install a Kates.

**PROPORTIONATE BLENDING CONTROL**




Where many ingredients go into one blend, and must be in exact proportion, a control *system* for each ingredient would cost plenty. But a Kates control on each feed does the job inexpensively, and each unit can be reset for a blend change.

**PRESSURE FILTRATION CONTROL**

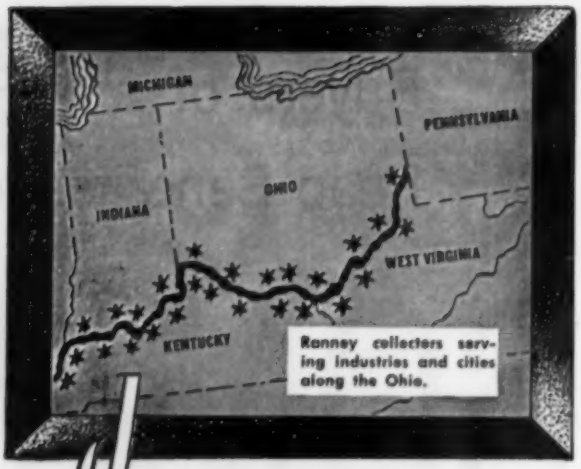



As filter cake builds up, a constant valve-jockeying is needed to smooth out flow. A Kates control in the effluent compensates for rising pressure drop, keeps filter at best rating.

***Write for Technical Bulletin — TODAY***

**Kates** | **W. A. KATES COMPANY**
**Department A.**
**430 Waukegan Rd.**
**Deerfield, Illinois**





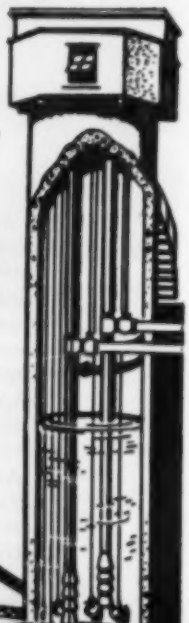

## Dipping our fingers in the Ohio!

**208.8 MILLION GALLONS PER DAY**

**Here is more proof** that the RANNEY METHOD is the most effective, economical means of collecting huge volumes of naturally filtered, non-turbid water.

**43 collectors,** representing 9 chemical plants, 2 distilleries, 2 Ordnance Plants, 1 Steel Company, and 3 Municipal Water Supplies, are now producing an abundant water supply by infiltration. Results here, as in so many areas, are highly satisfactory.

**Take advantage** of this low-cost insurance against water shortage problems, without the expense of filter plants and treatment stations.



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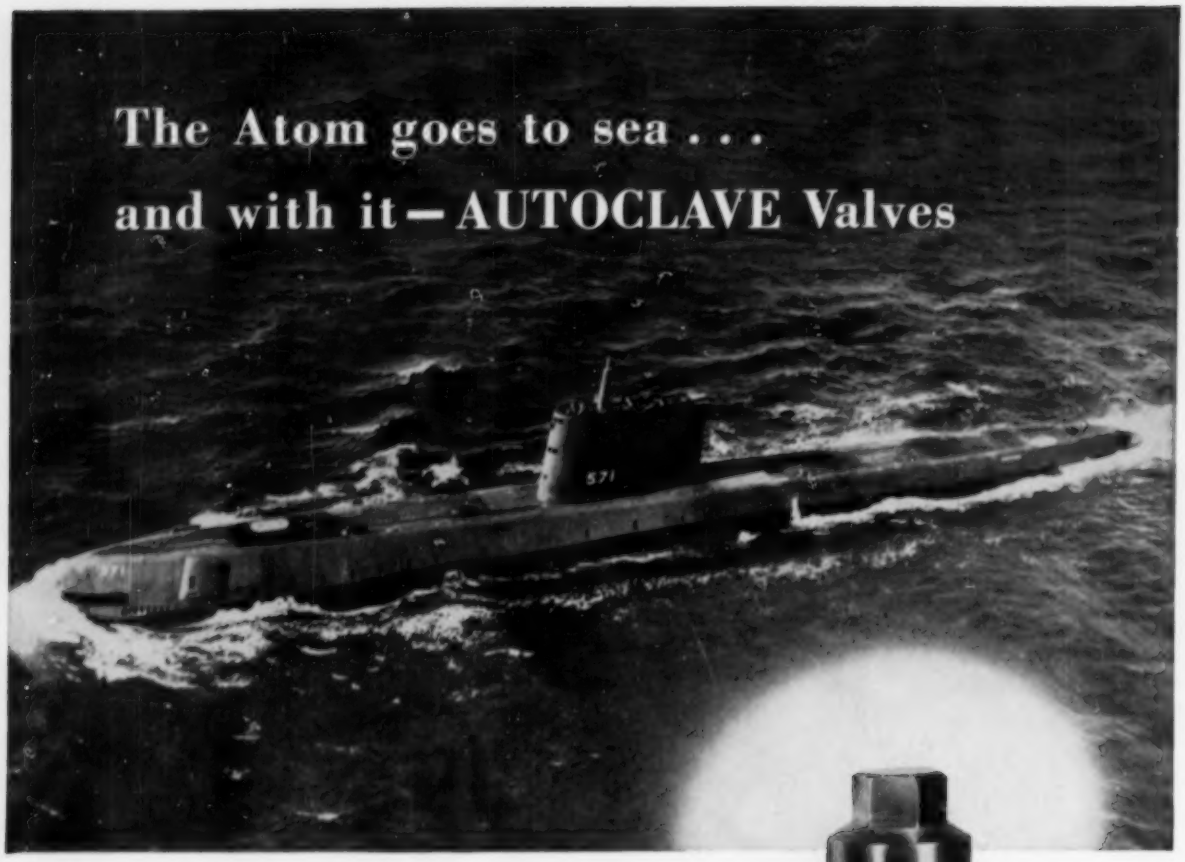
# The Atom goes to sea . . .
# and with it—AUTOCLAVE Valves




THE world's first atomic powered underwater ship—United States Navy Submarine Nautilus—carries within her hull, special valves engineered and manufactured by ▲ .

The same engineering skill and craftsmanship which ▲ contributes to the maritime alertness of the Nautilus, is available to you in meeting the problems of your research and development work. Consult with us on your pilot plant and laboratory requirements for high pressure equipment.

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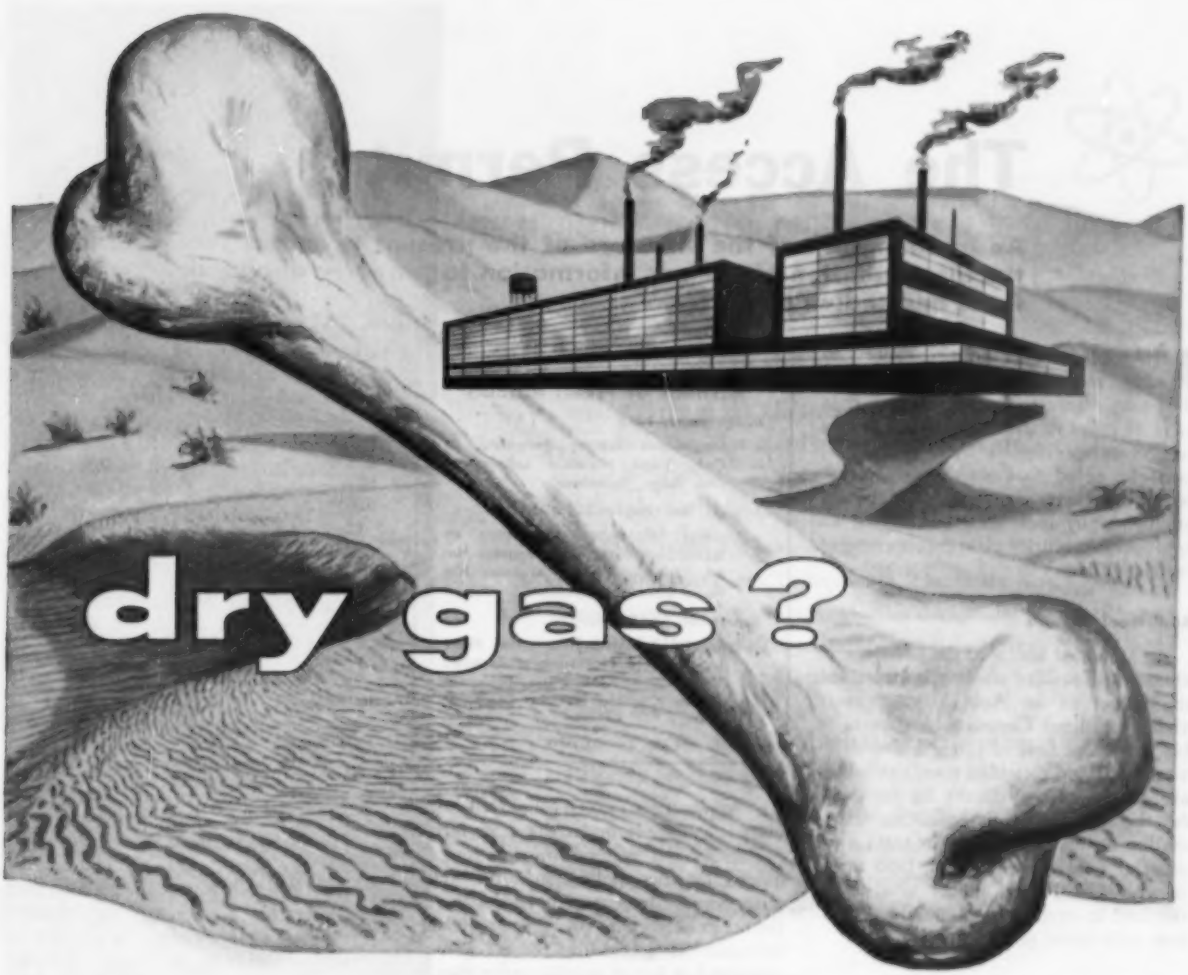
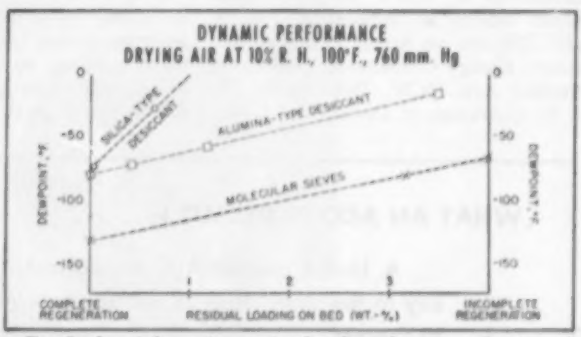



## Now you can dry gases drier than dry!

LINDE Molecular Sieves can dry your gases—air, hydrogen, chemical streams—more thoroughly than any other commercial adsorbent. They will duplicate laboratory performances—*in your plant*—under normal *production* conditions.

Even though your gas stream may already be partly dried, Molecular Sieves will remove the last traces of moisture. Only a small volume of adsorbent is required. The same combination of high capacity and low dewpoint is also obtained at high temperatures, up to 200°F.

This is SUPER-drying! Dynamic performance is shown in the accompanying graph. This superior performance also can be expected at higher relative humidities and at other temperatures and pressures. Of particular significance in production is the relative insensitivity of Molecular Sieves to incomplete regeneration.




For further information, write for data sheets on "Drying of Gases." Address Dept. CP-9 Linde Air Products Company, A Division of Union Carbide and Carbon Corporation, 30 East 42nd St., New York 17, N. Y.

Linde TRADE MARK MOLECULAR SIEVES

The term "LINDE" is a registered trade-mark of Union Carbide and Carbon Corp.

# The Access Permit

**An examination of the structure of the present program for the dissemination of nuclear information to properly qualified firms and individuals.**

All Access Permits authorize access to any "confidential data." In addition they may also cover such "secret" data as is included in the specific category or categories specified in the Permit. (It must be noted that an Access Permit is not a security clearance. It does not authorize any individual not having an appropriate security clearance to receive restricted data.)

#### Additional Benefits

As an added bonus to the privilege of obtaining classified nuclear information, the holder of an Access Permit may visit specialized Commission experts in his particular field of interest and is invited to attend classified meetings which are organized periodically by the AEC for the purpose of disseminating information to qualified people in certain industrial fields. (see list of 1956 meetings). The Permit holder is also authorized to exchange classified information with other permit holders.

#### How to get an Access Permit

Any company which feels it can demonstrate a useful need for access to confidential or secret restricted data should submit an application (Form AEC 378) for an Access Permit to the Atomic Energy Commission, 1901 Constitution Ave., N.W. Washington 25, D. C. (attention of Division of Civilian Application.) Self-employed individuals can apply under the same terms.

**MEETINGS OF PERMIT HOLDERS**

*March 21-22, 1956.*

Homogeneous Reactor Program. At Oak Ridge National Laboratory, Oak Ridge, Tennessee.

*July 31, and August 1-2, 1956.*

General Information Symposium on Radiation Effects. At Congress Hotel, Chicago, Illinois (Argonne National Laboratory, host).

*September 13-15, 1956.*

Industrial Technical Information Meeting on Cold Processing of Enriched Uranium. At Oak Ridge, Tennessee (Union Carbide Nuclear Company, host).

Besides the general information required by the application form, there must be a statement of potential use of the restricted data in the applicant's business. If access to "secret" data is requested, a list of specific categories by number is required, plus detailed reasons why such access within the specific categories is needed. The need for "secret" information should be stated by describing its proposed use in specific research, design, planning, construction, manufacturing, or operating projects; in activities under licenses issued by the Commission; in studies or evaluations planned or underway; or in work or services to be performed for other organizations. Commission officials emphasize that these last provisions are of vital importance—about half of the permit applications received to date have contained insufficient substantiation of the need for restricted data.

#### Who is not Eligible?

Under present AEC regulations, the following are not eligible to apply for Access Permits:

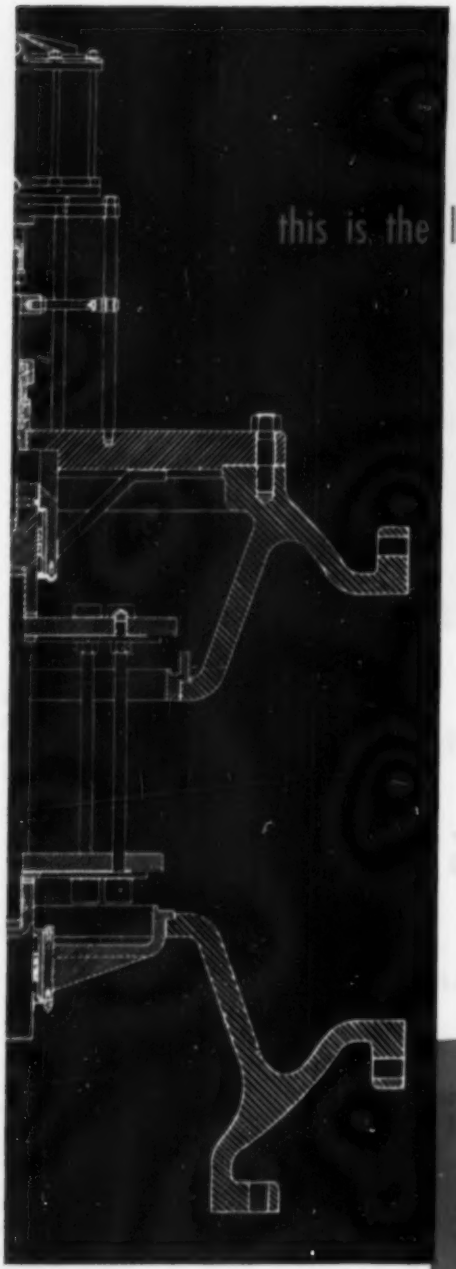
1. Corporations not organized under the laws of the United States;
2. Individuals not citizens of the United States;
3. Partnerships which do not have at least one U. S. citizen among the partners, or other unincorporated firms not having one or more U. S. citizens as principal officers;
4. Any organization which is owned, controlled or dominated by the government or a citizen of a country in the Soviet bloc, or organized under the laws of a country in that bloc.

The regulations reserve to the Commission authority to deny access permits to a person not expressly made ineligible, upon a Commission finding that the denial "is necessary or appropriate in the interest of the common defense and security."

(*Continued on page 90*)

**WHAT AN ACCESS PERMIT IS . . .**

- Under present AEC regulations, the Access Permit is the one indispensable key to the storehouse of nuclear energy data which is classified as "confidential" or "secret."
- For administrative purposes, the AEC has categorized "Restricted Data" which will be made available in a number of major categories as set forth in Appendix A (see page 91).
- Access Permits are intended to authorize access by organizations or by self-employed individuals to classified nuclear data (excluding information pertaining to weapons).



# this is the largest double-seated control valve ever made

When you are talking *big* control valves, talk to Kieley & Mueller. K&M is the largest manufacturer of the big ones, control valves above 16 inches. Standard globe-type valves are available in 20, 24, 30 and 36 inch sizes; even larger valves will be produced on special order.

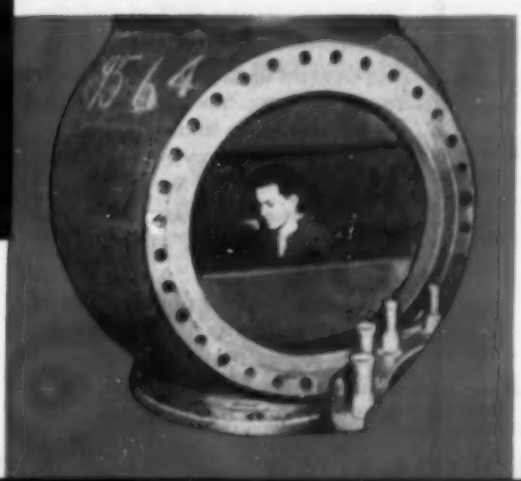
This 36-inch double-seated angle valve closes snugly on giant Teflon seats. The inner valve positions responsively, gliding on special roller-slide bearings. It's massive, but is operates protected by a K&M patented torque resistor. Beyond the problem of size, this valve is mounted on its side, and it has been performing creditably for over four years.

BIG or small, if it's control valves, you'll like the pitch-in, helpful approach of your local K&M representative . . . plus capable engineering and manufacturing follow-thru at the K&M plant.

*Write for Bulletin CV-53.*

**ABOVE:** Partial cross-section of K&M 36-inch valve showing general construction.

**AT RIGHT:** Actual size of a 36 inch valve can be visualized from this illustration of a workman inside the valve body performing finishing operations.



K&M

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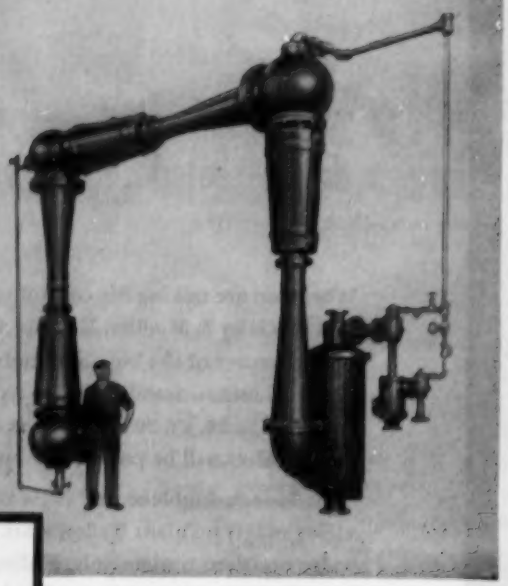
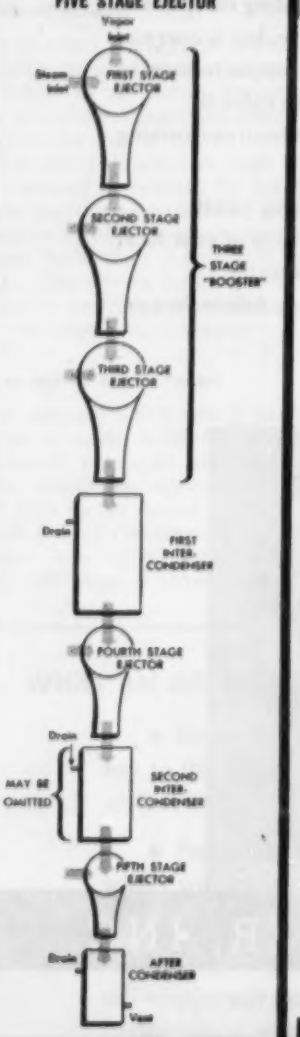
Designed to maintain low, absolute pressures



SIMPLIFIED SCHEMATIC of FIVE STAGE EJECTOR




ELLIOTT
*Multi-Stage*
EJECTORS

When absolute pressures ranging from .012 in (0.3mm) to about .003 in (0.075mm) mercury are required, five stage ejectors such as the one shown above are applied.

Condensers of either the barometric or surface type can be incorporated in this five-stage hook-up. The after-condenser may be used to recover the heat of the steam, to recover the condensate, or to eliminate noise and nuisance at exhaust.

For details on the complete line of Elliott ejectors, contact your Elliott representative or write Elliott Company, Jeannette, Pa. for descriptive bulletins.

GB-1

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STEAM TURBINES • MOTORS • GENERATORS • GENERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOBLOWERS • TUBE CLEANERS • STRAINERS


## ACCESS PERMIT

(*Continued from page 88*)

### Security Clearances

As noted earlier, possession of an Access Permit does not automatically authorize the holder to receive restricted data. Security clearances must first be obtained for all persons who will have access to the restricted material. For "confidential" data, only an "L" clearance is required, but for "secret" data it is necessary for the persons in question to have the higher "Q" clearance.

In addition, if the permit holder wishes to keep or store classified material, a "facility clearance" is also a prerequisite to obtaining classified data. This means that the permit holder must demonstrate that he has set up an adequate system for safeguarding the material once it is in his possession.

### How to Get a Security Clearance

Upon the granting of an Access Permit, the Commission will designate an office, usually an Operation Office, to process all personnel security clearances requested in connection with the permit and to provide information to the permittee with respect to the sources and locations of restricted data available under his permit. The first 25 clearances, either "Q" or "L," are free; additional clearances are charged at the rate of $265 for a "Q" clearance and $15 for an "L" clearance.

### Permanent Solution or Transitional Expediency?

The present system of Access Permits represents a middle-ground program designed to reconcile, at least partially, the need of private industry for nuclear energy data with the need for absolute security as far as purely military considerations are involved. It is reasonable to suppose that, as experience is accumulated on the workability of the system, changes and revisions will be made as they become necessary.

### Other Sensitive Fields

Nuclear energy is not the only field where the legitimate interests of Government and private industry are almost inextricably intertwined. For example, we need only cite the vast technological area involved in the development of guided missiles and in certain fields of electronics.

It is possible that the access permit program, which now applies only to nuclear energy developments, may prove to be the prototype of other similar systems covering wide sectors of our economy.

## APPENDIX A

### Categories of Restricted Data Available

**C-4 Chemistry—General**—Fundamental chemistry of elements and their compounds through element 92.

**C-7 Chemistry—Radiation and Radiochemistry**—Chemistry of radioisotopes and radioactive substances. Tracer chemistry.

**C-10 Chemistry—Separation Processes for Plutonium and Uranium**—Separation, decontamination and processing of plutonium and uranium.

**C-16 Chemistry—Transuranic Elements**—Chemistry of the transuranic elements and their compounds.

**C-20 Controlled Thermonuclear Processes**—Theory, design, development and operation of experiments on controlled thermonuclear reactions.

**C-46 Criticality Hazards**—Critical mass experiments. Safety precautions. Safe processing and storage of special nuclear materials.

**C-41 Health and Safety**—Biological and medical studies on radioactive and other toxic materials.

**C-22 Isotope Separation**—Isotope separation methods (except gaseous diffusion). Production and isolation of isotopes.

**C-37 Instrumentation**—Design, development, construction, testing and evaluation of instruments of all types.

**C-25 Metallurgy and Ceramics**—Metallurgy of non-fissionable substances, thorium, uranium 233 and all isotopic mixtures of U-235 and U-238. Ceramics and refractories not pertaining to plutonium technology.

**C-26 Metallurgy—Raw Materials**—Uranium, thorium, beryllium, zirconium ore and mineral beneficiation including equipment and analytical procedures.

**C-28 Particle Accelerators and High Voltage Machines**—Design, development, construction and operation of high-voltage machines and particle accelerators, including Van de Graaff generators, linear accelerators, cyclotrons, synchrotrons, bevatrons, X-ray machines, etc.

**C-34 Physics and Mathematics**—Basic physics and mathematics involved in design and construction of nuclear reactors.

**C-40 Radiation Effects on Reactor Materials**—Wigner effect, blisterings, effect of radiation on plastics, lubricants, etc.

**C-42 Reactors—Production**—Theory, design, construction and operation of Hanford and Savannah River production reactors.

**C-80 Reactors—Research and Testing**—Theory, design, construction and operation of reactors used as neutron sources.

**C-81 Reactors—Power**—Theory, design, construction and operation of nuclear reactors for power production.

**C-47 Technology—Feed Materials**—Large-scale production of intermediate and feed materials such as $UO_3$, $UO_2$, $UF_4$, $UF_6$, $ThO_2$, $ThF_4$.

**C-66, 67, 68 Technology—Hanford Processes**—Fuel element technology. Reactor technology. Separation process technology.

**C-55 Technology—Plutonium**—Metallurgy of plutonium and its alloys including plutonium recovery procedures.

**C-76, 77, 78, Technology—Savannah River Processes**—Fuel element technology. Reactor technology. Separations process technology.

**C-56 Technology—Tritium**—Scope of category classified confidential.

**C-70 Radioactive Waste**—Storage and disposal of natural and artificial waste radioactive materials.

*(See page 92 for list of current permit holders in the process industries)*

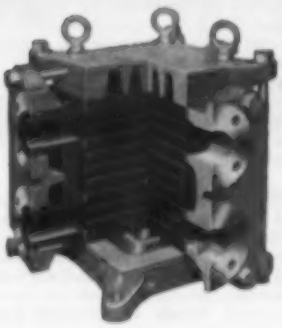

ONLY *Impervite*

**Gives You All Basic Designs Of**

**IMPERVIOUS GRAPHITE HEAT EXCHANGERS**

**CUBICAL**

Provides greatest amount of transfer surface possible for size of exchanger. (Example: Model 4 can provide 50 sq. ft. on one side and 90 on the other). This IMPERVITE exchanger can be operated up to 150 psi, 340° F. They can be easily modified to permit change of application, and special interconnectors allow economical use of banks of CUBICAL exchangers.



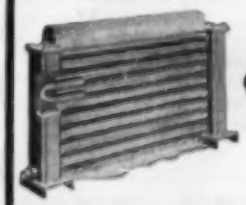
**TUBE AND SHELL**

You can get quick shipment on famous standard IMPERVITE tube and shell exchangers in sizes from 7 to 650 tubes, 9 and 12 ft. in length. In addition, flexible design and production facilities at Falls Industries enables custom units to be fabricated quickly and economically for practically any application.

**Design of these exchangers is such that corrosives only come into contact with IMPERVITE impervious graphite. This material is unaffected by the action of all corrosives except a few highly oxidizing agents, is immune to effects of thermal shock, and possesses an exceptionally high rate of thermal conductivity. An extensive variety of standard and special IMPERVITE processing equipment is available from Falls Industries for long-life, corrosion-free service.**

**CROSSBORE**

This new exchanger design is an exclusive Falls' development, which incorporates a "one-piece" bundle. It withstands operating pressures in the 150-200 psi range, resists greater physical shock, and is exceptionally easy to clean. Extreme simplicity of design provides truly maintenance-free operation.



**CASCADE**

All models utilize specially constructed low-pressure-drop ells. All tubing is extruded by an improved method which practically eliminates spalling at high temperatures and results in more uniform heat transfer characteristics.

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## ACCESS PERMIT

(Continued from page 91)

### CHEMICAL COMPANIES HOLDING ACCESS PERMITS AS OF JULY 31, 1956

**Petroleum**

American Oil Co. (Texas)—Conf.
Atlantic Refining Co.—Conf., C-4, C-7, C-10, C-22, C-37, C-28, C-34, C-80, C-81, C-70.
Continental Oil Co.—Conf., C-7, C-26, C-47.
Esso Research & Engineering.—Conf.
Gulf Research and Development Corp.—Conf., C-4, C-7, C-28, C-40.
Humble Oil and Refining Co.—Conf.
Magnolia Petroleum Co.—Conf.
Ohio Oil Co.—Conf., C-4, C-26, C-47.
Phillips Petroleum Co.—Conf., C-4, C-7, C-10, C-16, C-26, C-28, C-34, C-37, C-40, C-41, C-42, C-70, C-80, C-81.
The Pure Oil Co.—Conf.
Signal Oil & Gas Co.—Conf.
Sinclair Research Laboratories, Inc.—Conf.
Socony Mobil Oil Co., Inc.—Conf.
Standard Oil Co.—Conf.
The Standard Oil Co. (An Ohio Corp.)—Conf.
Stauffer Chemical Co.—Conf.
The Texas Company—Conf., C-4, C-7, C-40, C-41, C-70.

**Chemical**

Air Products, Inc.—Conf., C-22, C-56.
Allied Chemical & Dye Corp.—Conf., C-47.
American Cyanamid Co.—Conf., C-4, C-7, C-10, C-26, C-28, C-34, C-40, C-42, C-47, C-80.
American Lava Corp.—Conf.
American Potash & Chemical Corp.—Not available.
Anchor Hocking Glass Corp.—Conf.
Armstrong Cork Co.—Conf.
Atlas Powder Co.—Conf., C-47.
J. T. Baker Chemical Co.—Conf.
F. W. Berk & Co., Inc.—Conf.
The Borden Co.—Conf.
The Carborundum Co.— Conf.
Celanese Corp. of America—Conf.
Chemical Process Co.—Conf.
Columbia-Southern Chemical Corp.—Conf.
Commercial Solvents Corp.—Conf.
Corning Glass Works—Conf., C-4, C-7, C-25, C-40, C-41, C-70.
Diamond Alkali Co.—C-4, C-7, C-10, C-16, C-22, C-26, C-40, C-41, C-47, C-70, C-80, C-81.
The Dow Chemical Co.—Conf., C-4, C-7, C-10, C-16, C-46, C-22, C-25, C-26, C-28, C-34, C-37, C-40, C-41, C-42, C-47, C-55, C-56, C-70, C-80, C-81.
E. I. Du Pont De Nemours & Co., Inc.—Conf., C-4, C-7, C-16, C-22, C-25, C-26, C-28, C-34, C-37, C-40, C-41, C-42, C-46, C-47, C-70, C-80, C-81.
Eagle-Picher Co.—Not available.
Ethyl Corp.—Conf.
Ferro Corp.—Conf.
Foote Mineral Co.—Conf.
Geigy Chemical Corp.—Conf.
General Ceramics Corp.—Conf.
Gladding, McBean & Co.— Conf.
Great Lakes Carbon Corp.—Conf., C-7, C-25, C-26, C-34, C-40, C-80, C-42, C-81, C-70, C-47.
A. P. Green Fire Brick Co.—Conf.
The Hamilton Chemical Co., Inc.—Conf.
Harbison-Walker Refractories Co.— Conf., C-7, C-10, C-25, C-26, C-47, C-70.
The Hershaw Chemical Co.—Conf., C-41, C-47.
Hercules Powder Co.—Conf., C-47.
O. Hommel Co.—Conf.
Isotopes Specialties Co., Inc.—Conf., C-7.
Kawecki Chemical Co.—Conf.
Koppers Co., Inc.—Conf., C-4, C-7, C-10, C-16, C-25, C-34, C-37, C-40, C-41, C-46, C-47, C-55, C-68, C-70, C-78, C-80, C-81.
Larco Nuclear Instrument Co.—Conf., C-4, C-22, C-25, C-26, C-37, C-47.
Lindsay Chemical Co.—Not available.
Lithium Corp. of America, Inc.—Conf.
Mallinckrodt Chemical Works—Conf., C-46, C-47.
Manu-Mine Research & Development Co.—Conf.
Metal & Thermit Corp.—Conf.
Michigan Chemical Corp.—Conf., C-25, C-26, C-40, C-47.
Minerals Refining Co.—Conf.
Mitten Chemicals, Inc.—Conf.
Monsanto Chemical Co.—Conf., C-7, C-10, C-16, C-41, C-37, C-34, C-25, C-40, C-80, C-81, C-70, C-46, C-26, C-42, C-55.
National Aluminate Corp.—Conf.
New Process Metals, Inc.—Conf.
Olin Mathieson Chemical Corp.—Conf., C-4, C-7, C-10, C-16, C-40, C-41, C-46, C-70, C-81.
Owens-Corning Fiberglas Corp.—Conf., C-4, C-7, C-10, C-25, C-34, C-40, C-41, C-46, C-47, C-70, C-80, C-81.
Owens-Illinois Glass Co.—Conf.
Ozark-Mahoning Co.—Conf.
Pennsylvania Salt Manufacturing Co.—Conf., C-4, C-7, C-10, C-25, C-26, C-34, C-37, C-41, C-47, C-70.
Chas. Pfizer & Co., Inc.—Conf.
Procter & Gamble Co.—Conf.
Reichold Chemicals, Inc.—Conf., C-4, C-7, C-26, C-34, C-37, C-41, C-47, C-70.
Research Chemicals, Inc.—Conf., C-25.
Rohm & Haas Co.—Conf., C-26, C-4, C-7, C-10, C-16, C-25, C-26, C-40, C-41, C-42, C-47, C-55, C-70, C-80, C-81.
S. W. Shattuck Chemical Co.—Conf., C-47.
Shea Chemical Corp.—Conf.
Sigma Chemical Co.—Conf.
Speer Carbon Co.—Conf.
Spencer Chemical Co.—Not available.
Tile Council of America, Inc.—Conf., C-7, C-25, C-40, C-80.
Titanium Zirconium Co., Inc.—Conf.
Unexcelled Chemical Corp.—Conf.
Union Carbide & Carbon Corp.—Conf., C-4, C-7, C-10, C-16, C-46, C-41, C-22, C-37, C-25, C-26, C-28, C-34, C-40, C-42, C-80, C-81, C-47, C-55, C-70.
United States Yttrium, Inc.—Conf.
Velsicol Chemical Corp.—Conf., C-47.
Victor Chemical Works—Conf.
Virginia-Carolina Chemical Corp.—Conf., C-4, C-7, C-26, C-41, C-70, C-81.
Woodbury Clay Company—Conf.
Wyandotte Chemicals Corp.—Conf., C-47.

**Rubber Companies**

The Firestone Tire & Rubber Co.—Conf.
The B. F. Goodrich Co.—Conf., C-4, C-7, C-10, C-16, C-25, C-37, C-40, C-41, C-42, C-46, C-47, C-55, C-70, C-80, C-81.
The Goodyear Tire and Rubber Company—Conf.
Quaker Rubber Division, H. K. Porter Co., Inc. of Pittsburgh—Conf.
United States Rubber Company—Conf.

**Pharmaceutical Companies**

Abbott Laboratories—Conf.
Mead Johnson & Company—Conf.

**Other**

The Pfaudler Company—Conf., C-10, C-25, C-26, C-40, C-47, C-70, C-81.

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ACE VACUUM
TRAPS
7521 used for freezing out undesired vapors in the vacuum system; also can be used in conjunction with Dewar flasks.
Stocked as follows:
Diameter of Body, mm. 25 32 35 38
Length of Body, mm. 200 250 250 250
O.D. of Inner Tube, mm. 10 13 16 19
Price $3.75 $4.75 $4.90 $5.50
(Larger Sizes and Specials Quickly Available. 10% discount on $50.00 orders.)
7525 same as 7521 except with ℨ joint and mercury seal. By incorporating the ℨ joint the trap can be easily removed for cleaning.
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# HIGH CAPACITY CLEAN DISCHARGE WITH EIMCO PAN FILTERS

Detail of Eimco stainless-steel pan-filter showing flexible vacuum and blow connections to each pan. These are exclusive features on the Eimco Pan Filter — particularly advantageous when the slurries filtered require periodic clean-outs of internal parts.

Greater filtering capacity, cleaner discharge and superior washing and drying make the Eimco Pan Filter a highly efficient unit.

Each pan functions as an individual filter with feed, wash, dry and discharge cycles. The pans may be jet washed from the bottom, assuring a clean media during every revolution.

Eimco Pan Filters can be constructed from a wide range of materials to ensure long life and low maintenance when processing corrosive slurries. Materials such as rubber, plastic and many others may be bonded to the surface of the metal construction for protective coating or to prevent product contamination.

Pan filters are available in a variety of sizes from 10 to 500 square feet of filter area.

These and other outstanding features listed below in a comparison with table filters, make the Eimco Pan Filter the most practical and efficient horizontal type vacuum filter available.

| | TABLE FILTERS | EIMCO PAN FILTERS |
|---|---|---|
| Cake Discharge | Heel of cake remains on media. | Clean, full cake discharge. |
| Washing | No clear separation of wash. Cake remaining on media carries liquor past cake discharge point, diluting the strong filtrate. | Absolute separation of wash. |
| Media | Becomes blinded easily. Must stop to remove cake and wash. (Phosphoric acid operation requires considerable downtime.) | Media kept clean through wash during each cycle. Downtime minimum. |
| Removing, Repairing Media | Difficult repair job. | Media on each pan is easily and quickly changed or repaired. |

Let Eimco engineers consult with you on your filtration problem. For years they have made it their business — through research — to offer better liquid-solid separation through filtration.

**THE EIMCO CORPORATION**

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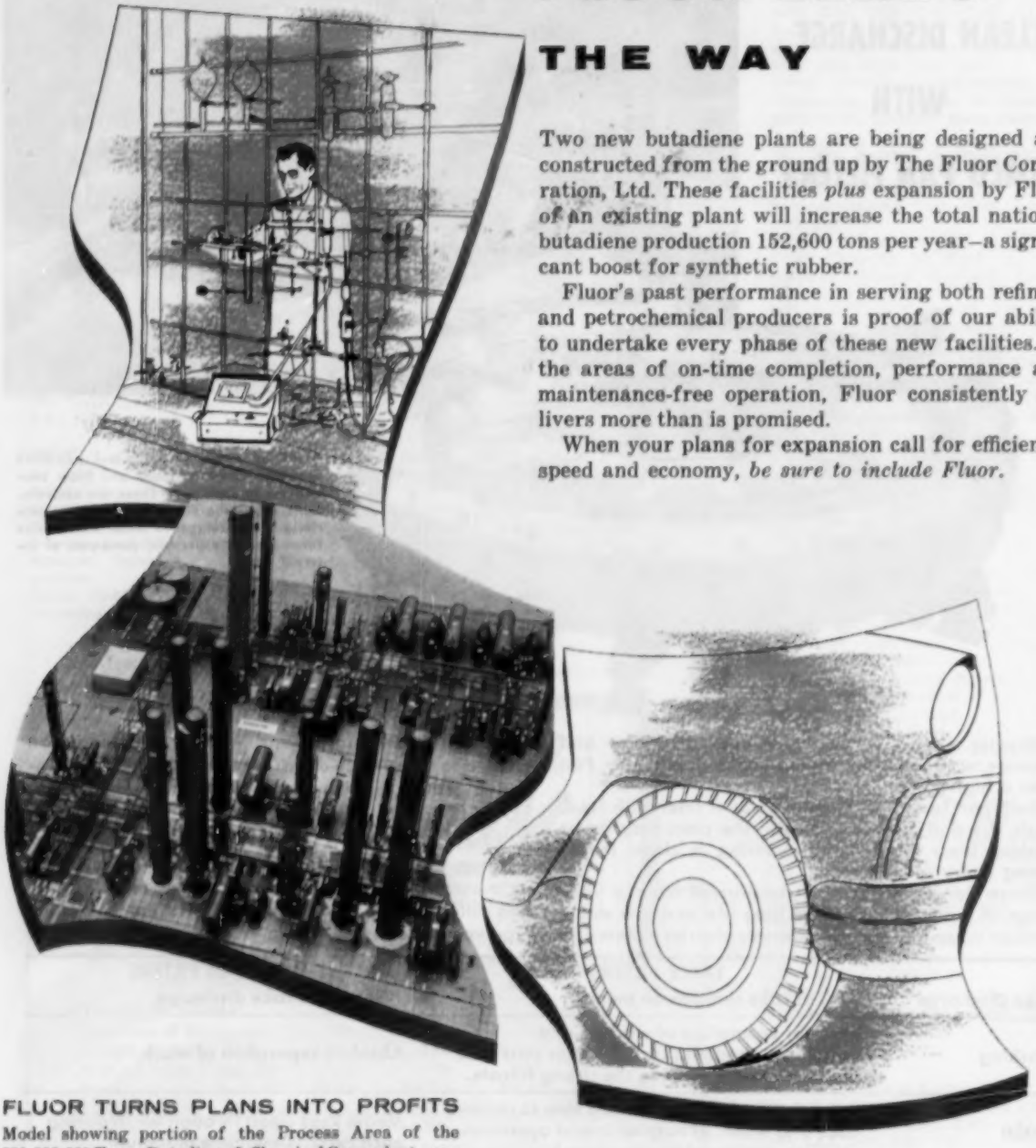
B-209

# IN BUTADIENE... FLUOR LEADS THE WAY



Two new butadiene plants are being designed and constructed from the ground up by The Fluor Corporation, Ltd. These facilities *plus* expansion by Fluor of an existing plant will increase the total national butadiene production 152,600 tons per year—a significant boost for synthetic rubber.

Fluor's past performance in serving both refiners and petrochemical producers is proof of our ability to undertake every phase of these new facilities. In the areas of on-time completion, performance and maintenance-free operation, Fluor consistently delivers more than is promised.

When your plans for expansion call for efficiency, speed and economy, *be sure to include Fluor.*

**FLUOR TURNS PLANS INTO PROFITS**

Model showing portion of the Process Area of the $30,000,000 Texas Butadiene & Chemical Corp. plant—one of two new butadiene facilities under way at Fluor. This important new petrochemical plant will produce both butadiene and aviation gasoline.

**FLUOR** *ENGINEERS and CONSTRUCTORS for the Petroleum, Chemical and Power Industries*

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| 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | |
| 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | |
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| 30L | 31A | 32A | 33A | 34B | 35A | 36L | 37A | 39A | 40A | 41A |
| 42L | 43A | 44A | 45A | 46A | 47A | 48A | 49A | 50L | 51A | 52A |
| 53A | 54L | 55A | 56L | 57A | 58A | 59R | 60A | 61A | 62L | 63A |
| 64A | 65A | 66L | 67A | 68A | 69A | 70L | 71A | 72A | 73A | 74A |
| 75A | 76A | 78A | 79A | 80L | 80R | 81R | 82L | 83A | 84L | 84R |
| 85A | 86A | 87A | 89A | 90L | 91R | 92L | 93A | 94A | 99A | 101R |
| 103R | 105R | 107L | 107R | 108L | 109R | 110TL | 110BL | 111R | 112L | |
| 112R | 113R | 114L | 114R | 115R | 116L | 117R | 118L | 118BR | 119R | |
| 120TL | 120B | 121R | 122L | 123R | 124L | 125R | 126L | 127TL | 127BL | |
| 127R | 128TL | 128BL | 128BR | 129R | 130L | 131R | 132L | 132R | 133R | |
| 135TL | 135BL | 135TR | 135BR | 136TL | 136BL | 137TR | 137BR | 139R | | |
| 140L | 141L | 141R | 142L | 143R | 144TL | 144BL | 145TL | 145BL | 145R | |
| 146TL | 146BL | 157TR | 157BR | 158L | 158BR | 159TL | 159BL | 159R | | |
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| 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | |
| 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | |
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| 30L | 31A | 32A | 33A | 34B | 35A | 36L | 37A | 39A | 40A | 41A |
| 42L | 43A | 44A | 45A | 46A | 47A | 48A | 49A | 50L | 51A | 52A |
| 53A | 54L | 55A | 56L | 57A | 58A | 59R | 60A | 61A | 62L | 63A |
| 64A | 65A | 66L | 67A | 68A | 69A | 70L | 71A | 72A | 73A | 74A |
| 75A | 76A | 78A | 79A | 80L | 80R | 81R | 82L | 83A | 84L | 84R |
| 85A | 86A | 87A | 89A | 90L | 91R | 92L | 93A | 94A | 99A | 101R |
| 103R | 105R | 107L | 107R | 108L | 109R | 110TL | 110BL | 111R | 112L | |
| 112R | 113R | 114L | 114R | 115R | 116L | 117R | 118L | 118BR | 119R | |
| 120TL | 120B | 121R | 122L | 123R | 124L | 125R | 126L | 127TL | 127BL | |
| 127R | 128TL | 128BL | 128BR | 129R | 130L | 131R | 132L | 132R | 133R | |
| 135TL | 135BL | 135TR | 135BR | 136TL | 136BL | 137TR | 137BR | 139R | | |
| 140L | 141L | 141R | 142L | 143R | 144TL | 144BL | 145TL | 145BL | 145R | |
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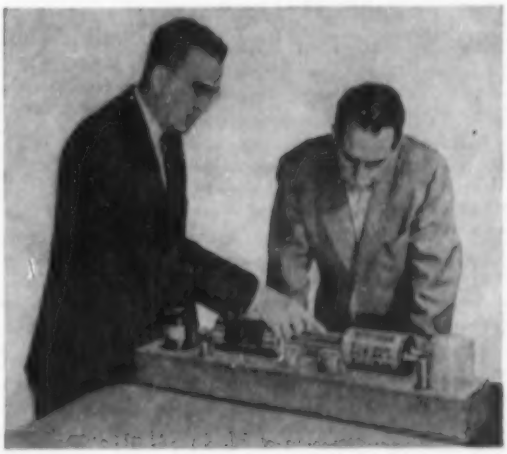
- **SERVICES**

## developments of the month–



**51 Nuclear Pump.** Byron Jackson Pumps, Inc. has announced the availability of an actual nuclear display pump for demonstration and study. The model will be made available without charge to engineering departments, associations, and other qualified groups for educational purposes.

This demonstration pump is an exact duplicate of a Byron Jackson "liner" type model, a number of which are currently in use in nuclear fluid processing operations. Transparent Lucite has been substituted for the center pump housing to permit observation of the pump's inner construction and operation.

Dimensions are 6" by 8" by 36" and total weight is about 55 lbs. According to the company, assignment of the touring display will be made on a "first to request" basis.

(Continued on page 96)

TURN THIS PAGE TO RIGHT FOR MORE . . .

HOW TO USE THIS POST CARD FOLDER

**Merely encircle numbers on cards to get literature desired. On advertised products in front of magazine, fold this page out to right. For those in back, fold card strip again to right, where card strip is scored for detaching.**

# products-

## advertised in this issue

**IFC Technical Literature.** Carbide & Carbon Chemicals Co. offers series of booklets giving uses, physical properties, specifications on wide variety of chemical products.

**3R Sifter.** The Bar-Nun Rotary Sifter has many operating advantages in the sizing of dry chemicals. B. F. Gump Co.

**4A Demisters.** York Demisters, product of Otto H. York, Inc., are designed to improve performance of any type of evaporator.

**6A Stainless Steel.** G. O. Carlson, Inc. specialize in the fabrication of stainless steels for the nuclear power industry.

**8L Wire Screens.** Cleveland Wire Screens are available in all corrosion-resistant metals & alloys. Can be woven to individual specification for every purpose. Cleveland Wire Cloth & Mfg. Co.

**9A Valves.** The new Durco Type F Valve is now available from Duriron Co.

**10L Filters.** Adams IWF filters come in a wide range of sizes and multiple combinations for chemical process applications. Cleaning without disassembly. R. P. Adams Co., Inc.

**11A Gyratory Screen.** Stacked-deck design of Allis-Chalmers stainless steel gyratory screen provides up to 35 sq. ft. of screening area in 16 feet of floor space.

**12A Scintillation Crystals.** Harshaw sodium iodide (thallium) scintillation crystals for gamma radiation detection instruments assure high purity, clarity and proper activation. Harshaw Chemical Co.

**13A Struthers Wells Corp.** is a major supplier of circulating hearting systems for both liquid and vapor service. Also fired heaters for direct heating of process fluids.

**15A Super Classifier.** The Sharples Super Classifier offers product recovery of 80% to well over 90% in the classification of dry powders. Sharples Corp.

**16A Flow Instrumentation.** Foxboro instrumentation assures optimum results in measurement or control of process flow streams. The Foxboro Co.

**18L Mixers.** Continuous or batch mixing or blending of pulverized or granular, wet or dry materials. Readco Spiral Ribbon Mixers supplied for atmospheric, elevated pressure or vacuum operation. Read Standard Corp.

**19A Valves.** Rockwell Mfg. Co. Nordstrom valves give you extras not available in ordinary valves. Pressurized lubrication eliminates costly wearing friction.

**21A Engineering Services.** The Badger Manufacturing Co. offers the utmost in speed and efficiency in the design and construction of chemical process units.

**22A Electromagnetic Pumps.** General Electric electromagnetic pumps, first designed for radioactive and high-temperature systems, now used in liquid metal laboratories and other processes where minimum leakage and continuous operation are important.

**24A Insulation.** Better insulation service is provided by new insulation divisions at Johns-Manville.

**25A Flow Control Systems.** The Pottermeter is a "bearingless" flow meter unaffected by caustics, acids, corrosives. Reliable under extreme temperatures and pressures. Potter Aeronautical Co.

**26A Sodium.** U. S. Industrial Chemicals Co. furnishes sodium metal in any form or quantity for any industrial use.

**27A Vertical Pumps.** Ingersoll-Rand vertical process pumps are engineered specifically for low-capacity high head applications. Available in many materials of construction.

**28A Mechanical Seals.** One mechanical seal adaptable to high or low temperature, corrosive, or high pressure services with only change in gasket. Byron Jackson Pumps, Inc.

**29A Engineering Services.** Catalytic Construction Co. provides "on time—on budget" engineering services for the metallurgical, chemical, petrochemical and oil refining industries.

**30L Cooling Tower Power Unit.** The Marley cooling tower power unit consists of motor, drive shaft, couplings, Geareducer, and fan hub, assembled and permanently aligned on unitized steel support. For new or existing towers. The Marley Co.

**31A Process Filters.** Units from Process Filters, Inc. which filter everything from cumic acid to green salt, & from cyanide slimes to molten sulfur.

**32A Mixers.** Philadelphia Mixers are built for long trouble-free service. Philadelphia Gear Works.

**33A Graphite Process Equipment.** Karbate process equipment offers unequalled corrosion resistance, immunity to thermal shock and ruggedness of mechanical design. National Carbon Co.

**34B Instruments and Automation.** The Barton Instrument Company's new integrated plant in Monterey Park, Cal., assures greater and more efficient production.

**35A Nuclear Products.** Superior Tube announces opening of its nuclear products division, specially equipped to produce precision products and to perform many operations on materials for nuclear power installations.

**36L Oil Reclaimer.** The Hilco Oil Reclaimer purifies vacuum pump oil by continuous recirculation, either on a full-flow or by-pass basis, or intermittently on a batch basis. Hilliard Corp.

**37A Photocopy Machine.** The Apeco Dial-A-Matic Auto-Stat makes instant photocopies of anything written, printed, typed, drawn or photographed in your own office. American Photocopy Equipment Co.

**39A Pumps.** Standard End Suction Centrifugal Pumps, made by Worthington Corp., offer advantage of interchangeability of parts—70,480 possible combinations.

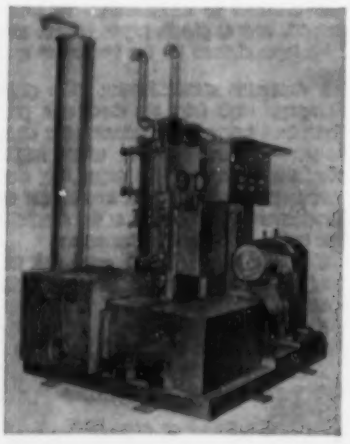
**40A Alloy Valves.** Design of Cooper Alloy valves stems from first hand experience with field problems.

**41A Silicone Defoamer.** The new Antifoam B gives you the ultimate in foam-killing convenience. Said to last longer. Dow Corning Corp.

**42L Pulverizers.** Schutz-O'Neill pulverizers offer versatility in the production of medium-coarse, fine and microfine powders of all types.

**43A Carbon and Graphite Products.** Finishing operations on electrodes, anodes and mold stock are performed with the utmost precision by the Great Lakes Carbon Corp.

**44A Valves.** Crane valves and fittings are being widely adopted in the design of the newest nuclear power plants.



## DEVELOPMENTS OF THE MONTH *(Continued)*

**52 Liquid Oxygen Pump.** Engineers of Superior Air Products Co. have designed a new pump and vaporizer for pumping oxygen, nitrogen or argon from a liquid state at low temperature and pressure to a gas of any desired pressure up to 5,000 lb./sq.in.

The pump can be manufactured in a range of capacities from 250 to 30,000 cu.ft./hr. and can be operated from a liquid storage tank or direct connected to a liquefier. It is driven by electric power. Electricity or steam may be used to supply heat for vaporizing.

(Continued on page 97)

**45A Filters.** Sparkler Horizontal Plate Filters and undisputed first choice with engineers who have had occasion to thoroughly test this type of filter. Sparkler Manufacturing Co.

**46A Stainless Steel.** The Sun Shipbuilding and Dry Dock Co. is equipped to handle any job demanding stainless or other alloy steels.

**47A Raschig Rings.** Lapp Raschig rings are smooth, completely vitrified, strictly non-porous and iron-free. Lapp Chemical Porcelain.

**48A Lead Shielding.** Any type of lead shielding—bricks, sheet, slab or sleeving will be custom built by National Lead Co. Standard forms also available.

**49A Catalysts.** Highly active cobalt molybdenum catalysts specially developed for the desulfurization, denitrification and stabilization of petroleum stocks. The Girdler Co.

**50L Rupture Disc.** Even tougher applications respond to model DV rupture discs. Opening 1 through 36 in. Black, Sivalls & Bryson, Inc.

**51A Teflon.** Chemically inert Teflon simplifies design in new mechanical seal. E. I. Du Pont de Nemours & Co.

**52A Lithium.** Lithium metal, two metal derivatives, and 15 salts are available from the Lithium Corp. of America, Inc. Technical data sheets.

**53A Synthetic Calcium Silicates.** Micro-Cel mineral filler serves to absorb liquids, provide bulk, prevent caking, control viscosity, extend pigments, aid suspension and reduce surface sheen. Johns-Manville.

**54L Conveyor Dryer.** A comparatively small Apron Conveyor Dryer for pilot plant production adaptable to expansion for future needs. National Drying Machinery Co.

**55A Jet Apparatus.** Condensed bulletin on all types of SK jet apparatus. Also consulting services. Schutte and Koerting Co.

**56L Shielding Windows.** The Corning Radiation Shielding Window, product of the Corning Glass Works, is non-browning, has non-diminishing shielding and abrasion resistance. Technical bulletin gives properties and characteristics.

**57A Under Fired Dryers.** Bartlett-Snow are designers, engineers, fabricators and erectors of oil or gas fired batch type dryers.

**58A Drying Equipment.** Highest product uniformity can be assured by the installation of Proctor dryers. Proctor & Schwartz, Inc.

## DEVELOPMENTS OF THE MONTH *(Continued)*

**53 Electro-pneumatic Controller.** An improved electro-pneumatic controller for measurement and control of current to AC motors or other AC circuits is offered by the Hagan Corp. The controller uses no vacuum tubes or transistors. By converting current measurement to a pneumatic signal, all the advantages of pneumatic instrumentation are obtained. It can be used to measure single phase alternating current in a power line or in one leg of a three-phase motor. Current can be limited to a predetermined maximum or maintained at a "set point" value. In measurement applications its pneumatic signal can be used with standard pneumatic recording or indicating instruments.

(Cont. on page 98)

**Numbers without letters indicate data available as described in Data Service "Briefs." Numbers with letters refer to further data concerning products advertised in this issue. Letters indicate position of advertisement on page (if more than one on a page)—L, left; R, right; T, top; B, bottom; A indicates full page; IFC, IBC, and OBC are cover advertisements.**



Postage Will Be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 48890, Sec. 34.9, P. L. & R., New York, N. Y.

CHEMICAL ENGINEERING PROGRESS
25 West 45th Street
New York 36,
New York

Postage Will Be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 48890, Sec. 34.9, P. L. & R., New York, N. Y.

CHEMICAL ENGINEERING PROGRESS
25 West 45th Street
New York 36,
New York

# products-

## advertised in this issue *(Cont.)*

**89R Package Pump.** New Verti-Line pumps. Capacities to 7,500 gal./hr., 2 through 7½ h.p. Layne & Bowler Pump Co.

**60A Pipe Insulation.** Called Unibestos, a single-layer insulation for joint protection. Union Asbestos & Rubber Co.

**61A Gas Separation.** If low-temperature separation is in your processing plans consult Air Liquide.

**62L Gaskets.** Made of Dupont nylon, Chemiseal gaskets & accessories for chemical piping are available from U. S. Gasket Belmont Packing.

**63A Plant Construction.** Geon polyvinyl chloride resins fabricated in a Girdler engineered & constructed plant. Complete service available.

**64A Plant Sites.** Norfolk and Western Railway services an area especially suited to chemical plant construction. Write for facts.

**65A Ion Exchange.** See the illustration of nine ways to deionize water. These systems with equipment & resins produced by Permutit Co.

**66L Mixers.** If you are not getting well balanced performance from your mixers consult Paul O. Abbe for aid in solving your problems.

**67A Dowtherm.** If your product requires high process heat, further data on this medium will be valuable. Dow Chemical Co.

**68A Vaporizer System.** Where large quantities of chlorine in dry gaseous form are required Whitlock Mfg. Co. system provides high capacity at low cost.

**69A Film-Type Evaporator.** A new unit from Pfaudler Co., a wiped-film evaporator for vacuum distillation. Also a new glassed steel Autoclave.

**70L Flexible Strut Joints.** Barco Mfg. Co. joints are simple & versatile. Sizes 1 to 6 in., capacities 8,500 lb. to 120,000.

**71A Ammonium Nitrate.** This new type of prilled ammonium nitrate was produced in a plant built by Chemical and Industrial Corp. using the Stengel Process.

**72A Packless Valves.** Precision made & designed specifically for use with heavy water, molten metals & radioactive coolant service. Wm. Powell Co.

**73A Mercury Arc Rectifiers.** Unique construction coupled with cooling coil design of Allis-Chalmers Co. units results in better rectifier operation.

**74A Chempumps.** Elimination of seals, stuffing boxes & leakage in these pumps solves the problem of difficult-to-handle fluids. Variety of materials of construction. Chempump Corp.

**75A Thorium.** The combined program instituted by Davison Chemical Co. & Rare Earths, Inc., has resulted in expanded production, sales, research & development of thorium & other rare earth compounds.

**76A Silica Alumina Catalysts.** For maximum process economy consider the wide variety of silica alumina catalysts offered by Houdry Process Corp.

**78A R.D.C. Column.** General American Transportation Co. will make specimen runs on your materials & develop reliable plant scale designs for you. Consult them.

**79A Ceramic Balls.** These heat transfer & catalyst support mediums are proving effective in various platinum catalyzed refining operations. U. S. Stoneware Co.

**80R Gages.** No matter what the temperature of your liquids there is a Jerguson Gage & Valve Co. unit to suit your need.

**80L Lab Ware.** Vitreosil ware has met the most exacting needs of laboratories everywhere. Large available stock of all sizes & types. Prompt fabrication on special items. Thermal American Fused Quartz Co., Inc.

**81R Defoaming Unit.** Called Versator, a multi-purpose process unit for simultaneous use in defoaming & homogenizing. Easy to clean. Cornell Machine Co.

**82L Centrifugal Pump.** Eastern Industries, Inc. model D-11 has proven extremely successful because size & weight make it ideal. Available in many metals.

**83A Petroleum & Petrochemical Process Equipment.** M. W. Kellogg Co. employees through their professional organizations keep informed with the newest in techniques & practices in their fields & pass this knowledge along to you in equipment design & fabrication.

**84R Infiltration.** The Ranney Method originated by Water Suppliers, Inc., has proved an effective, economical means of collecting large volumes of naturally filtered, non-turbid water. Investigate.

**84L Regulators.** W. A. Kates Co. direct-acting flow rate regulators are complete units which operate economically. Details available.

**85A Atomic Energy Facilities.** The Ralph M. Parsons Co. will undertake your atomic facilities from design through operation.

**86A Autoclave Valves.** The same skilled engineering which built the valves for the Nautilus is available to you to meet your research problems. Consult Autoclave Engineers.

**87A Molecular Sieves.** To dry your gases drier than dry & duplicate laboratory performance in your plant, consider Linde Air Products Co. molecular sieves. Data available.

**89A Control Valves.** For sizes above 16 in., also standard globe type to 36 in. & over, ask Kieley & Mueller for information.

**90L Ejectors.** Elliott Co. multi-stage ejectors are designed to maintain low, absolute pressures. Ask for descriptive bulletins.

**91R Heat Exchangers.** Made of Impervite, an impervious graphite, these heat exchangers are designed so that corrosives contact only graphite which remains unaffected. Falls Industries, Inc.

**92L Vacuum Traps.** You can freeze out undesired vapors by using Ace Glass, Inc. vacuum traps. See list of available units.

**93A Filters.** The Eimco Corp. stainless steel pan-filter shown illustrates the flexible vacuum & blow connections to each pan. Available in sizes 10 to 500 sq. ft.

**94A Butadiene Plants.** Fluor Corp., Ltd., leads the way in erection of plants for production of butadiene. If you plan such a plant consider including Fluor.

**99A Spray Dryer.** The new Bowen Engineering, Inc., semi-works spray dryer is compact, gives high yield, easy to clean, & economical to operate. Literature on request.

**101R Heat Exchangers.** Industrial Filter & Pump Mfg. Co. designs exchangers for the job. Complete design & fabrication service.

(Continued on page 100)

## DEVELOPMENTS OF THE MONTH *(Continued)*

**54 Thickness Gage.** Tracerlab's new Model BG-10 Automatic Standardizing Beta Gage is now available to manufacturers of sheet materials such as plastic, paper, rubber, etc. Advantages claimed for the instrument are:

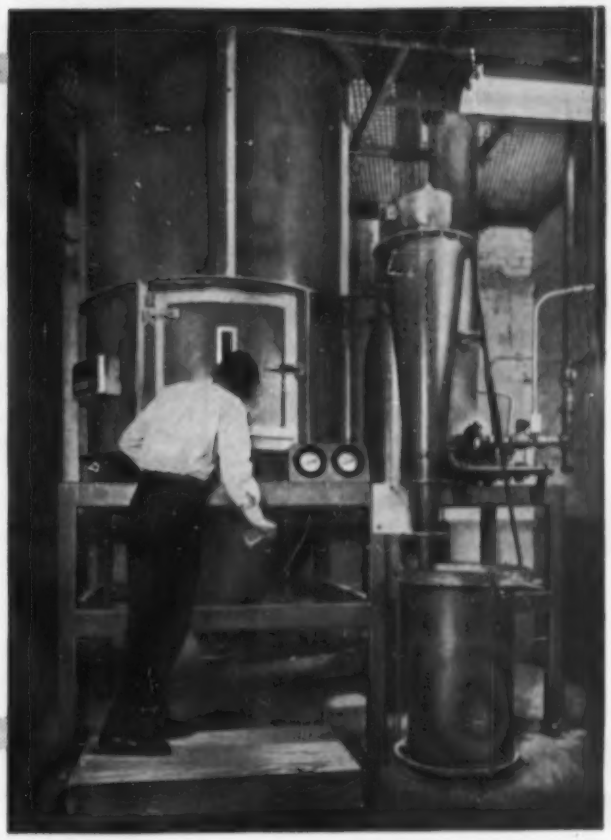
1. Automatic standardization. The gage disengages itself from the sheet at a predetermined interval and automatically compensates for any variables which might affect the accuracy of the gage. This also compensates for the gradual wearing out of the electronic tubes as well as the depreciation in life of the radioactive source.
2. Requires only limited space. If desired, the unit can be separated so that only a minimum of space is taken at the machine.
3. Simple operation. No long training period required for operators.
4. Easy to maintain.
5. Rugged industrial construction.

(Continued on page 100)

# new

## BOWEN SEMI-WORKS SPRAY DRYER

★ COMPACT
★ HIGH YIELD
★ EASY TO CLEAN
★ LOW OPERATING COSTS



From one position the operator can observe the chamber interior, read the inlet and outlet temperatures and adjust the air heater.

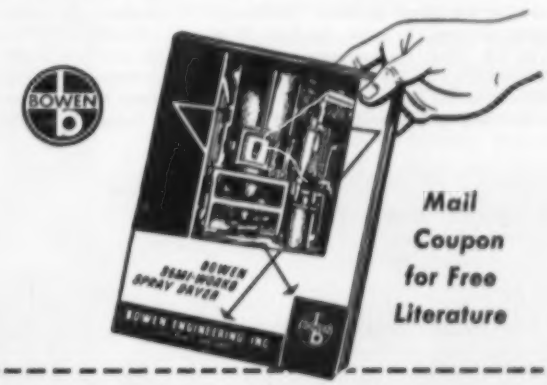
● **At last a fully prefabricated spray dryer requiring only hours to erect.** The new reasonably priced Bowen Semi-Works Spray Dryer makes available a small, compact unit requiring a working area of only 7 x 9 feet, completely prefabricated and transportable through usual factory openings. Surfaces in contact with the product and feed material are of stainless steel thruout. Drying temperatures are variable between 200°F and 750°F to accomodate a wide variety of materials.

**BOWEN ENGINEERING, INC.**
NORTH BRANCH 13, NEW JERSEY

Recognized Leader in Spray Dryer Engineering Since 1926

**BOWEN SPRAY DRYERS**
*Always Offer You More!*

An interesting illustrated booklet, Bulletin 36, is available. Send for it today.




*Mail Coupon for Free Literature*

**BOWEN ENGINEERING, INC.**
NORTH BRANCH 13, NEW JERSEY

Please send me Free Literature on Bowen Semi-Works Spray Dryer.

NAME_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____

# products-

## advertised in this issue *(Cont.)*

**103R Vaporizers.** Illustrated: a vertical steel vaporizer of reboiler type, capacity 10,000 gal. butane per hour, in shell; steam inside tubes. Richard M. Armstrong Co.

**105R Flowmeters.** Fischer & Porter Co., Flowrator meters with true percentage scales available from stock. See list of advantages.

**107R Pumps.** A report on how to get best service from your pumps. Data Sheets available. Aldrich Pump Co.

**107L Plastic Ductwork.** If yours is a problem of corrosion American Agile Corp. is available for consultation. Ask for brochure.

**108L Process Units.** Manning & Lewis Engineering Co. will design, engineer, & fabricate heat exchange & process equipment for your specific need.

**109R High-Nickel Castings.** Knowing how much nickel, chromium & other alloying elements goes into casting depends on experience. Duraloy Co. makes available the services of their metallurgist to study your problem.

**110TL Process Weighing.** Build profits using the Glengerry Processes Inc. system of timed, automatic weighing of dry components in the process stream.

**110BL Job Opportunities.** Fundamental research, information on missile development, new propellants & materials are only a few of the areas in which jobs are open at the Jet Propulsion Laboratory.

**111R Rotary Dryer.** Hardinge Co., Inc., offer the Ruggles-Coles pilot plant unit for small capacity or laboratory operations.

**112R Vertical Shaft Drive.** Called MotoReduceR this vertical speed reducer from Philadelphia Gear Works, Inc., has unique single casing & bolted-on motor construction.

**112L Diaphragm Control.** For use on low pressure applications requiring changes of fractions of inches of water (pressure). See list of features. Mercoid Corp.

**A.I.Ch.E. MEMBERSHIP**

Brochure—"Know Your Institute"—tells objective aim and benefits to chemical engineers who join this nation-wide organization, includes membership blank. Circle number 55 on Data Post Card.

**113R Steel & Alloy Plate Fabrication.** Featured, the 42 ton stripper built by Downingtown Iron Works, Inc., specialists in heat exchanger & steel & alloy plate fabrication.

**114R Mixers.** The Alsop Engineering Corp. portable mixer may be clamped in place on any open vessel. Sizes 1/20 to 7 1/2 h.p. Choice of motors & materials of construction.

**114L Rare Earth & Thorium Chemicals.** Lindsay Chemical Co. can make prompt delivery of these materials whether you need a gram or a carload.

**115R Analysis Systems.** A data file on complete analysis systems is available from Arnold O. Beckman, Inc.

**116L Stainless Steel Tubing.** Tube Methods, Inc. stainless tubing has now had atomic experience added to that in other fields. Diameters .050 to .625 in. O.D.

**117R Mixing Equipment.** See the list of features offered in the Simpson Mix-Muller from National Engineering Co. Controlled mixing results in effective materials utilization.

**118BR Aero Spray.** Called Marla Spray Penetrating Oil & available from the Rathlen Corp., material said to be more effective than ever. Has advantages of assured penetration, speed, economy, etc.

**118L Squirrel Cage Motors.** Called Varidyne a new simple means for simultaneous speed variations. U. S. Electrical Motors, Inc.

**119R Spray Dryers.** For custom drying test runs Nichols Engineering & Research Corp. can meet your requirements with their Nerco-Niro service.

**120TL Paper Machinery.** Investigate the list of units available for making paper. United Paper Machinery Corp.

**120B Steel Plate Structures.** Posey Iron Works, Inc. build to your specifications. Requests for information invited.

**121R Wire Cloth.** Anti-corrosion wire cloth & wire cloth parts are the specialty of Newark Wire Cloth Co. Catalog.

## DEVELOPMENTS OF THE MONTH *(Continued)*

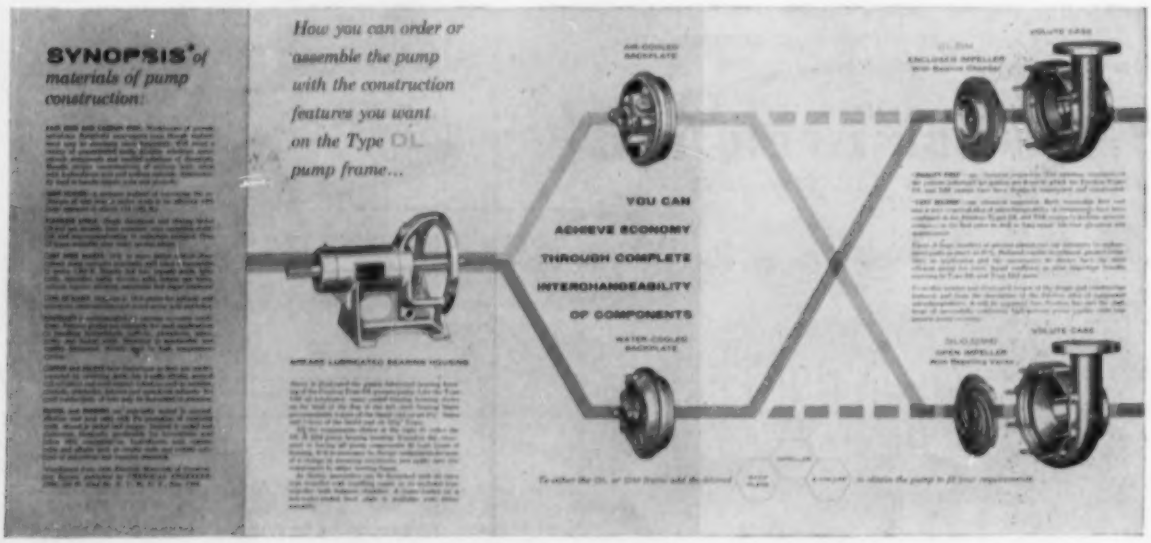
**56 Interchangeable Pump Components.** The Peerless Pump Division, Food Machinery and Chemical Corp., has recently introduced a new line of chemical process pumps characterized by almost complete interchangeability of parts. To either the Type DL or Type DM frame, the user simply adds the desired back plate (air or water cooled), the desired impeller (open, with repelling vanes, or enclosed, with balance chamber) and the appropriate volute case to build the proper pump for intended service. The manufacturer states that by such interchangeability of components process pump users can cut inventory on replacement parts up to 85%.

In addition to reduced capital investment, the user gets greater versatility and the opportunity to have always the most efficient pump for every liquid service.

Types DL and DM are available in discharge sizes from 1 in. through 4 in. and capacities up to 800 gpm.

The concept of component interchangeability illustrated by this line of pumps has been the subject of several recent articles in CEP. See articles by D. S. Ullock in CEP for May, 1955 and January, 1956 as well as articles by Lawrence, Brand and Murdock in CEP for April, 1956.

(Continued on page 102)


SYNOPSIS of materials of pump construction
How you can order or assemble the pump with the construction features you want on the Type DL pump frame...
YOU CAN ACHIEVE ECONOMY THROUGH COMPLETE INTERCHANGEABILITY OF COMPONENTS

✓ **CHECK** *your Data Service requests on the handy postcard on page 95 to*

▶ **GET** *up-to-the-minute catalogs, data sheets and bulletins on new chemical products, processes and equipment.*

**122L Heat Exchangers.** Standardized for quick delivery & designed to meet exacting requirements, stainless steel heat exchangers from Doyle & Roth Mfg. Co., Inc.

**123R Hydrocarbon Resins.** If you compound rubber consider Panarez hydrocarbon resins. Available in flaked or solid form. Pan American Corp.

**124L Industrial Periscopes.** Kollmorgen Corp. units are used at the major atomic installations. Check the list of advantages & custom features.

**125R Protective Coatings.** Atlas Mineral Products Co. produces a protective coating for every purpose. Ask for further data.

**126L Oil & Water Coolers.** Paracoil type P exchangers are aiding in the solution of industrial problems. Davis Engineering Corp. can make prompt delivery.

**127B Laminated Fiberglas.** Available from Schori Process Div. of Ferro-Co Corp. Ionyte tanks, crocks, & ducts fabricated to your specifications.

**127TL Spray Nozzle.** Spraying Systems Co. 48-page catalog includes a unit sure to meet your requirements. Complete with performance data.

**127BL Flow Indicator.** Provided with a dual scale for water or air Schutte and Koerting's Fig. 18123 ball flow indicator. Made of bronze in sizes for ¼ to 2 in. pipe connections.

**128BR Portable Filters.** Recommended for small batches where sludge or filter aid is required, the Ertel Engineering Corp. portable unit.

**128TL Precision Bore Stirrers.** Units have interchangeable parts. Styles to meet every laboratory need. Wilmad Glass Co.

**129R Vertical Pumps.** From Lawrence Pumps, Inc. vertical top-suction liquid oxygen pumps. Fabricated from metals not affected by extreme low temperature.

**130L Multi-Wash Collectors.** The high efficiency of Multi-Wash units has caused dust fumes, acid gases & odors to yield. Information available. Claude B. Schneible Co.

**131R Chlorination.** Wallace & Tiernan, Inc. chlorination system corrects problems caused by algae growths in your process. Their Harchem Division offers sebacic acid with outstanding features.

(Continued on page 102)


# When your process runs a temperature

ASK ABOUT

*Industrial*

# HEAT EXCHANGERS

**The most efficient heat exchangers are designed for the job.** The problems of thermal shock, corrosive liquids and gases vary so widely that only a tailored heat exchanger can give real assurance of safe, long use.

**Industrial offers complete design and manufacturing service.** Experienced engineers will give you fast accurate answers to the questions of size, single or multiple pass, concentric tube, or tube bundle, series or parallel. Industrial's plant is large and versatile . . . able to machine and fabricate any required materials . . . and ship completely assembled exchangers.

**On your next heat transfer problem call Industrial, for experienced engineering.**

***In advance—Write for***
**"Heat Transfer Equipment"**
**Bulletin 600-2.**

INDUSTRIAL

FILTER & PUMP MFG. CO.

5910 Ogden Avenue • Chicago 50, Illinois

*Industrial*

# products-

## advertised in this issue *(Cont.)*

**132R Jet Mixer.** Called Hi-Speed, the Hermes Machine Co. jet mixer has a shearing action which breaks down agglomerates to particle size.

**132L Thermocouple Insulators.** Cloud S. Gordon Co. Serv-Rite units assure you of plus values.

**133R Rotary Pumps.** Sier-Bath Gear & Pump Co. Hydrex pumps can be direct-connected to 1,800 rev./min., capacities 1 to 350 gal./min. to 500 lb./sq. in.

**135BR Spray Lubricant.** Called Marla, this open gear spray lubricant said to outlast ordinary lubes 5 to 1. Sticks to metal. Rothlan Corp.

**135BL Laboratory Glassware.** Be sure to get highest quality laboratory glassware by using Diamond D Blue Line from Doerr Glass Co.

**135TR Rotary Pumps.** Available from stock a low-cost, low-volume pump for corrosive liquids. It's the Eco Engineering Co. All-Chem rotary pump.

**135TL Materials Control.** The new Roto-Bin-Dicator mounts outside the bin at any angle. Explosion-proof U.L. listed units available. Also the Bin-Flo Aerator. The Bin-Dicator Co.

**136TL Demineralizers.** If water is used in your manufacturing operations learn how the Barnstead Still & Demineralizer Co. can help you maintain purity.

**136BL Adjustable Sprocket Rim.** A long list of advantages results from use of the Babbitt Steam Specialty Co. adjustable sprocket rim with chain guide.

**137TR Stills.** To solve the large variety of water problems stills & demineralizers may both be required. Barnstead Still & Demineralizer Co. has a unit for every pure water need.

**137B Laminates.** Bonate glass reinforced polyester, epoxy, & phenolic laminates are used in fabrication of ducts, pipes & ventilators to cut installation & maintenance costs. Carl N. Beetle Plastics Corp.

**139R Automatic Tank Gauges.** Use of these units in the petrochemical service insures accuracy & safety. Varec units from Vapor Recovery Systems Co. have many other advantages.

**140L Nuclear News.** Walter Kidde Nuclear Laboratories are industry consultants on applications of nuclear technology. Some of their current projects are listed.

**141R Chemical Engineering Catalog.** Whether you need data on washing machines or other chemical equipment consult CEC published by Reinhold Publishing Corp.

**141L Plastic Pipe, Fittings & Valves.** Vanton Pump & Equipment Corp. offers three lines of these units which give excellent corrosion resistance & are economical to use.

**142L Gaskets.** Garlock Packing Co. has available more than 2,000 units. Gaskets are Teflon-jacketed for resiliency & chemical resistance.

**143R Tray Dryers.** For wet powdered sensitive or unstable materials there is a unit available from C. G. Sargent's Sons Corp. Details on request.

**144BL Process Heat & Radiation Problems.** Astra offers R & D services for investigating possibilities & evolving methods. Nuclear Technology folder.

**144TL Process Units.** Artisan Metal Products, Inc. can supply you with process units for both pilot plant & processing equipment. Ask their engineer to call.

**145TL Books.** The Ronald Press Co. offers three new books. See the list with descriptions of contents.

**145R Pumps.** If you need efficient, carefree service you can depend on SSV pumps from Frederick Iron and Steel, Inc. Check list of features.

✓ **CHECK** *your Data Service requests on the handy postcard on page 95 to*

▶ **GET** *up-to-the-minute catalogs, data sheets and bulletins on new chemical products, processes and equipment.*

**145BL Nuclear Engineering.** A home study course on nuclear engineering has been prepared by Institute of Scientific Studies.

**146BL Filters, Blenders, Packagers.** Bowser, Inc. systems speed liquids from receipt to delivery. Equipment on lease or purchase.

**146TL Compressed Gases.** Custom-mixed Geiger Counter gases are the products of The Matheson Co., Inc. Cylinders in four different sizes.

**157TR Packings.** Durametallic Corp. packings are self-lubricating, long-lasting & save at point of sealing. Data file.

**157BR PVC Plug Valve.** For reduction of costs in handling corrosive fluids, Tube Turns Plastics, Inc. plastic plug valves. Sizes 1/2 to 2 in. Free booklet.

**158BR Diaphragm Pump.** If it's tough to pump investigate the T. Shriver & Co., Inc. diaphragm pump. Easy to inspect & clean.

**158L Spray Nozzles.** A complete selection of spray nozzles for washing, cooling, processing & other applications fabricated by Binks Mfg. Co.

**159R $CO_2$.** See how $CO_2$ can work for you. Combined with Liquid Carbonic Corp. know-how it does many important jobs.

**159TL Pumps.** For use in pumping liquids, gases & slurries without corrosion or contamination investigate the wavelike motion of the Sigmamotor Inc. pump.

**159BL Jet Equipment.** Whether your need is for steam jet ejectors, condensers, or vacuum equipment the Jet-Vac Corp. can supply your needs.

**160L Filters.** Filter efficiency is based on accurate test equipment. Airpure filters tested for 99.95% efficiency. Flanders Mill, Inc.

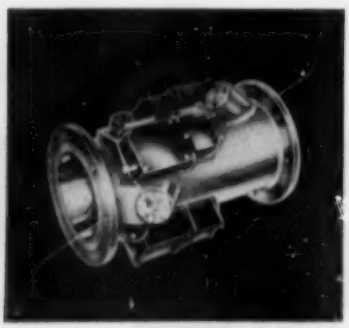
**161R Chill-Vactor Units.** The Croll-Reynolds Co., Inc. Chill-Vactor systems are economical the year 'round. No moving parts—no lubrication—low maintenance cost.

**IBC Process Pumps.** Milton Roy Co. controlled volume pumps range in capacity from 3 ml./hr. to 45 gal./min., pressures to 50,000 lb./sq.in.

**OBC Mixers.** Mixing Equipment Co. are specialists in fluid mixing. Read their suggestions for outsmarting fluid mixing costs.

## DEVELOPMENTS OF THE MONTH *(Continued)*

**57 Ultrasonic Flowmeter.** A new ultrasonic flowmeter, manufactured by the W. L. Maxson Corp., measures mass and volume rate and totalization for any liquid.



Simultaneous readout of mass flow rate, mass totalization, volumetric flow rate, volumetric totalization, and fluid density can now be obtained in a simple direct-reading instrument especially designed to measure fluid flow accurately at high transfer rates, as in fuel gaging for aircraft and missiles.

This new instrument utilizes ultrasonic energy to determine the volume or the mass of fluid passing through a smooth-bore sensor that interposes no obstruction to free flow of the fluid and therefore causes no additional pressure drop. It will handle up to 720,000 lb. or 90,000 gal. of jet fuel per hour at an accuracy of 1%.

The sensor for a four-inch line is only ten inches long and weighs only ten pounds. Detailed data are available from the manufacturer.

(Continued on page 104)

## equipment-

**1 Centrifugal Pumps.** A complete line of cradle-mounted centrifugal pumps is described in a new Ingersoll-Rand bulletin. Rating and performance tables are shown for the entire line along with cross-section views of design features. Pumps described have capacities from 5 to 2,800 gpm and pressures of 10 to 525 feet total head.

**2 Electric Motors.** U. S. Electrical Motors has just released a new bulletin with descriptions and full-color illustrations of open-type Uniclosed designs, totally-enclosed and explosion-proof types, Varidrives, Syncrogears, & right-angle worm gear models.

**3 Suspension Hopper Scale.** Cumulative weighing from either a series of feeders or a single hopper is possible with an automatic suspension-type hopper scale announced by Richardson Scale Co. Available in seven models, from 33 cu.ft. to 200 cu.ft. with capacities up to 6,000 lbs. Circle number 3 for complete details.

**4 Grain Shipping Scale.** Large volumes of free-flowing grain can be rapidly & accurately weighed by automatic bulk grain shipping scales described in 4-page bulletin offered by Richardson Scale Co. Capacities from 15 bu. to 25 bu. of grain per weighing. Accuracy within 1/10 of 1%.

**5 Bagging Scale.** Power-driven belt-fed bagging scale will sack 25, 50 & 100 lb. bags at rates up to 15 bags a minute. Specially adapted to handle all types of dry feeds. Richardson Scale Co.

**6 Sanitary Ferrotraps.** Permanent non-electric magnet separators specifically designed for installation in liquid processing equipment. Provide low-cost, effective, sanitary protection against contamination of product or machinery damage by fine iron and tramp iron. Bulletin from Eriez Manufacturing Co.

**7 Plastic Tubular Guard.** Lucite tubular guards replace metal guard rods for protection of tubular gage glasses on liquid level gages. Features are greater safety & protection and better visibility. Available in standard design, lengths to specification. Jerguson Gage & Valve Co.

**8 Variable Speed Drives.** New Twin-V tandem belt design introduced by Worthington Corp. Advantages are: compact compounded sheave design, automatic positive belt tensioning, constant speed regulation, automatic belt tension indicator and driving pin construction. Bulletin giving all mechanical and operating details furnished.

**9 Plastic Pipe, Fittings, Valves.** PVC (unplasticized, unmodified polyvinyl chloride) pipe & fittings offer outstanding chemical resistance, are light in weight, non-toxic and non-flamable. Styrene-copolymer pipe & fittings are tough, with

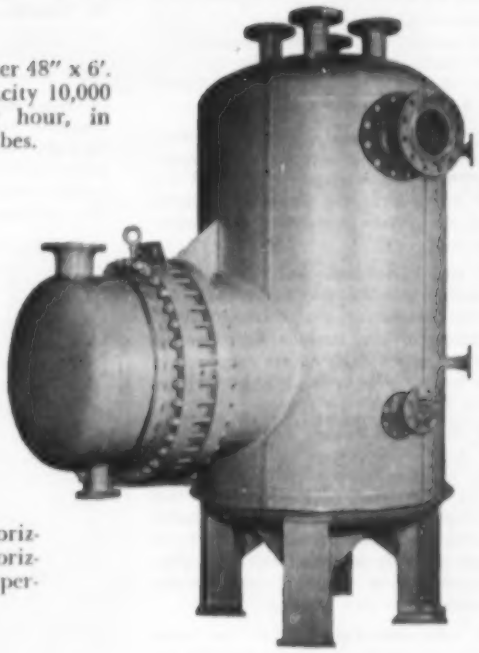
(Continued on page 104)


Chemical Engineers Appreciate

*Armstrong's*

Better Approach to

VAPORIZING PROBLEMS



Vertical Steel Vaporizer 48" x 6'. Reboiler Type. Capacity 10,000 gals. of butane per hour, in shell; steam inside tubes.

Built as straight vaporizers or combined vaporizers with built-in superheating sections.

For Ammonia can be furnished with tube bundle of SS 304, or SS 304L, to assure freedom from corrosion.

We make also two basic types of vertical bayonet vaporizer. Type One—general purpose—for field use in vaporizing propane or butane. Type Two—heavy duty, using heavy TEMA R type of construction for refinery or chemical plant construction.

Heavy duty type built specially to suit the individual case, rugged refinery construction, well suited to both Chlorine and Ammonia.

***We Invite Your Inquiries on Vaporizing Problems***

RICHARD M. ARMSTRONG CO.
BOX 188
WEST CHESTER PENNA.

## equipment-

high impact strength, offer broad chemical resistance, & are non-contaminating to food products or sensitive chemical solutions. Buna N pipe, fittings & valves can handle many organic and inorganic solutions at temperatures up to 225° F. Catalog from Vanton Pump & Equipment Corp.

**10 Single Plane Swivel Joints.** Designed primarily for hydraulic & pneumatic service, these leakproof, flexible connectors are offered in ¼", ⅜", ½", & ¾" sizes. Joints are of compact, lightweight, unitized construction with steel sleeve and aluminum casing. A special plastic back-up ring with O-ring static seal provides leakproof seal. Further information sent on request by Barco Manufacturing Co.

**11 Industrial-Hospital Ambulance.** Small electric-driven ambulance unit for industrial plant use. Ample space for attendant and for stretcher, oxygen equipment, medical bag, etc. Details from West Coast Machinery, Inc.

**12 Liquid Level Indicators.** Yarway remote indicators give accurate, instantaneous, eye level readings at any convenient plant location. Widely used in high pressure boiler applications, they are approved by the Power Boiler Code. Four-page bulletin from Yarnall-Waring Company.

**14 Centrifugal Pumps.** An improved line of A-S-H Hydroseal pumps for hydraulic ash handling systems described in data sheet from Allen-Sherman-Hoff Co. Uses photographs, schematics & line drawings to illustrate design, construction & operation of these abrasion resistant pumps. Capacity tables & related data includes friction loss in pipe & fittings.

**15 Differential Refractometer.** An 8-page brochure from Barnes Engineering Co. concerns itself with a complete description of this new differential refractometer. Discusses theory & principles of refractometry; measurement of refractive index, its significance when done continuously for process industries.

**16 Combustion Control Handbook.** Key components of combustion control systems described in detail with diagrams. Complete "dictionary" of control terminology. Cleveland Fuel Equipment Co.

**17 Separators.** Capacity charts, cross-sectional diagrams, description of all types of heavy-duty separators. Centrico, Inc.

**18 Granulator.** Model 542 granulator with high speed mechanical drive providing both rotary and oscillating motions available from Arthur Colton Co.

**19 Flammable Liquids Safety Manual.** Characteristics, hazards and safe handling of flammable liquids discussed in series of brochures from Protectoseal Co. First three sections with cover binder sent on request, other sections will follow automatically.

**20 Process Instruments.** Descriptive bulletin from Beckman Instruments, Inc. Many pictures.

**21 Compressor Trouble Shooter.** Booklet from Worthington Corp. helps to locate & correct troubles in common air-cooled & water-cooled compressors.

**22 Chromatograph Data.** Schematic diagram, other technical data on new vapor phase chromatograph contained in bulletin offered by Consolidated Electrodynamics Corp.

**23 Variable Speed Drives.** 8-page bulletin from Worthington Corp. contains selection information on variable speed drives. Engineering features, remote controls, etc.

**24 Vacuum Pumps.** Several bulletins available from Schutte & Koerting on SK Steam Jet Vacuum Pumps.

**25 Drain or Sampling Valves.** Two-page data sheet gives details and features of new drain or sampling valve in sizes from ¾ in. up to 2 in. Jerguson Gage & Valve Co.

**26 Centrifuges.** Technical bulletin describes nozzle type centrifuges manufactured by the Sharples Corp.

**27 Blowers.** Four-page bulletin contains selection charts and other engineering information on "Standardaire" blower, adaptable to either vacuum or pressure service. Read Standard Corp.

**28 Centrifugal Pumps.** Catalog sheet with "rate of flow" chart, other technical details on Bart "Flex-Seal" centrifugal pumps. Bart Mfg. Corp.

**29 Expansion Joints.** 72-page catalog on complete line of packless corrugated expansion joints. 150 photos, many tables & charts. Zallea Brothers.

**30 Pressure Filters.** Dorr-Oliver Hi-rate pressure filters are designed for high capacity water filtration. Bulletin.

**31 Process Control Instrumentation.** Feedback Controls, Inc. offers new brochure describing latest systems of design techniques in the servo mechanism field.

**32 Butterfly Valves.** Specification sheet on line of V-port butterfly valves announced by Hagan Corp.

**33 Digital Flow Rate Indicator.** Fischer & Porter announce a new direct-reading digital indicator designed primarily for use with turbine flowmeters. Details on request.

**34 Remote Metering System.** Bulletin describes features, applications, future expansion provisions of simple remote metering system with "plug in" construction. Sparks-Withington Co.

**35 Rotary Pumps.** Performance and selection charts, tables on friction loss, pressure, viscosity conversion, etc. in 24-page catalog. Foster Pump Works, Inc.

**36 Solid Shaft Motor.** Vertical shaft connection for directly applied power simplifies hookup and unitizes motor with driven machine, insures positive alignment & quiet operation. U. S. Electrical Motors, Inc.

**37 Mixers.** Specifications, operating features, on complete line of double paddle change-can mixers described in new bulletin from Cincinnati Hildebrand Co.

**38 Demisters.** Chemical & petroleum applications, engineering and installation data. Bulletin from Otto H. York Co.

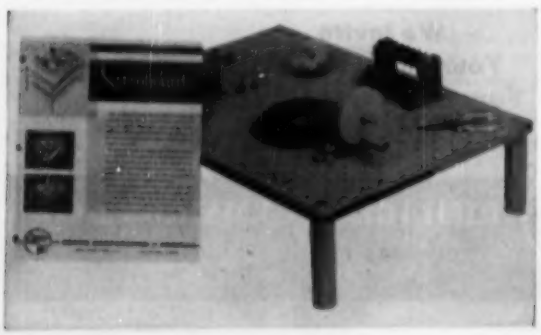
**39 Stainless Steel Equipment.** All types of stainless steel equipment custom built for the processing industry. Illustrated catalog. O. G. Kelley & Co.

**40 Spray Rinse Valve.** Glassed steel valve eliminates manual cleaning of glassed steel reactors. Pfaudler Co.

**41 Humidity Instruments.** Conversion tables of wet & dry bulb temperatures & psychrometric tables contained in 22-page bulletin from the Bristol Co. Also informa-

## DEVELOPMENTS OF THE MONTH *(Continued)*

**58 Electro-mechanical Assembly Kits.** Servoboard electro-mechanical assembly kits are intended to help the engineer in design and development work. Appropriate components are quickly and easily assembled to test, correct and finally prove the design of a control system, computer sub-assembly, motor drive gear train, or any other set-up requiring a combination of electrical and mechanical components. Servoboard kits combine hangers (standard sizes for almost every commercial electronic servo component) shafts, gears, couplings, adapters, clamps, clutches, differential, cam and microswitch, pulse disc, load disc, limit stops, terminal assemblies, dial assembly or handcrank. Three kits are available, depending on specific needs. A twelve-page brochure will be sent by the Servo Corp. of America.



✓ **CHECK** *your Data Service requests on the handy postcard on page 95 to*

▶ **GET** *up-to-the-minute catalogs, data sheets and bulletins on new chemical products, processes and equipment.*

tion on indicating, recording, & automatically controlling wet & dry bulb instruments & psychrometers.

**42 Buyer's Guide.** All types of corrosion-resistant equipment are described in the latest edition of the Pfaudler Co's Buyer's Guide. Emphasis on glassed steel equipment.

**43 Digital Computer.** The Librascope LPG-30 is a general purpose electronic digital computer smaller than the average desk with speed and memory capacity comparable to those of much larger computers. Low price. Applicable to many chemical processing needs. Details available from Librascope, Inc.

**44 Continuous Filters.** Complete line of continuous filters—string, scraper, horizontal, precoat, & roller discharge types. Bulletin from Filtration Engineers, Inc.

**45 Lubricating Systems.** Trabon Engineering Corp. specializes in centralized lubricating systems for all types of process applications. Complete catalog will be sent. Many tables and charts.

**46 Kettles.** New catalog on line of kettles for the chemical industry. Steam-jacketed kettles, mix cookers, pressure cookers, tilting kettles, vacuum kettles, etc. Copper & Brass Works.

**47 Meters & Controls.** Over one hundred measuring, transmitting, receiving, recording, and indicating instruments are described in an 8-page bulletin from Bailey Mater Co.

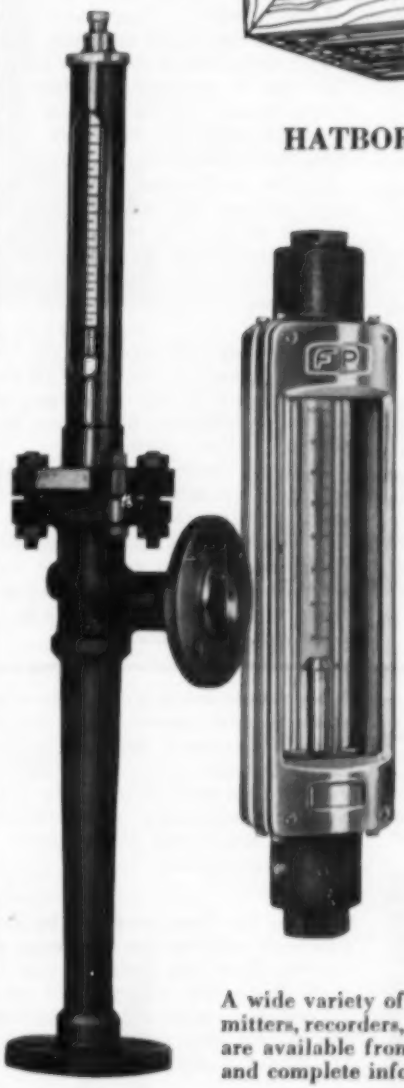
**48 Multi-wash Collectors.** Chart giving capacities and dimensions of multi-wash collectors contained in bulletin from Claude B. Schneible Co. Capacities from 575 to 47,200 cu.ft./min.

**49 Instruments.** Illustrated catalog from Minneapolis-Honeywell Regulator Co. contains condensed descriptions of all types of industrial instruments and references to detailed literature.

**50 Thermo-Panel Coil.** The Dean Thermo-Panel Coil replaces pipe coils, tubing coils, and jackets in solving steam or other heating and cooling problems. More efficient job at lower cost. Dean Products, Inc. Bulletin.


# F&P Flowmeters

**HATBORO, HOUSTON, CHICAGO OR LOS ANGELES**



Predictable performance floats permit Flowrator Meters with true percentage scales to be carried in stock. You benefit from F&P's years of hydraulic research by getting accurate meters quickly.

Greater flexibility of use is assured by the ease and simplicity with which new flow factors may be determined on changes in fluid service. Capacity may also be altered by revising metering float weight and yet, the same metering accuracy is maintained.

**Advantages of specifying F & P Meters:**

- Highest quality—same as made-to-order, extended shipment instruments.
- Prompt delivery—most items shipped the same day the order is received.
- Economy—standardization on percentage scales and interchangeable parts, minimizes spare part problems.

A wide variety of flow indicators, purgemeters, transmitters, recorders, controllers and pressure instruments are available from stock. Write today for Catalog #2 and complete information.

**FP FISCHER & PORTER**

LA 1101

1196 County Line Road, Hatboro, Pa.

In Canada: Fischer & Porter (Canada) Ltd. Toronto 18, Ont.

# UNIQUE SODIUM-DEUTERIUM POWER REACTOR TO BE INSTALLED IN ALASKA

**Highly significant reactor development is authorized under AEC's Power Demonstration Reactor Program.**

**Key: A sodium-deuterium reactor operates at high efficiency on low-enriched fuel, or in plants of 50,000 kw capacity or higher, on natural uranium.**

So far, all sodium cooled reactors have used graphite as a moderator. Now, AEC has approved the negotiation of a contract with Chugach Electric Association of Anchorage, Alaska, and the Nuclear Development Corp. of America, for a power reactor of 10,000 kw capacity using heavy water as moderator, liquid sodium as coolant and slightly enriched uranium as fuel. The plant would be located at Anchorage.

Significance of this development is threefold:

- Alaska is a high-cost power area, where atomic power could become economically competitive sooner than in most areas of the country.
- The low-enriched fuel of the reactor type makes it an attractive reactor for foreign use.
- The sodium-deuterium reactor has long been considered nearly ideal by nuclear experts, but has lagged due to a lack of technological knowledge. The new reactor will be both a research tool, to gain more knowledge of the technology, and the first of its type to actually operate.

### Advantages

Advantages claimed for the sodium cooled, deuterium moderated reactor are impressive:

1) It operates on a low-enriched fuel, or, in plants of 50,000 kw capacity or over, on natural uranium.

2) The reactor is suitable for power generation over a wide range of power levels without radical design changes.

3) It provides a long fuel lifetime and a high burnup of contained U-235 (50%) and produced plutonium (25%). Plutonium is produced in sodium-deuterium reactors in the ratio of three plutonium atoms for each four U-235 atoms undergoing fission.

4) The combination of low enrichment fuel and high burnup opens the prospect of disposing of spent fuel elements without reprocessing in the event that chemical reprocessing costs remain higher than the value of the fuel to be recovered.

5) By using sodium coolant, the reactor will deliver heat at very high temperatures without high pressures—heat will satisfy demands of modern high efficiency turbine systems.

6) Entire reactor system operates under low pressures, obviating need for large, expensive pressure vessel.

7) Heavy water moderator offers more efficiency than graphite or light water since heavy water absorbs fewer neutrons, and the moderator can be removed easily and quickly.

### Disadvantages

Disadvantages of the system include the necessity for keeping the sodium and deuterium separated at all times, making it necessary to use stainless steel pipes to enclose the sodium at some loss of efficiency. Corrosion, long a major problem of the system, necessitates the use of stainless steel. Result is a certain neutron loss. Heat losses carried away in the moderator are also a disadvantage.

### Economics

Engineers of Nuclear Development Corp. predict that full development of this type of reactor will result in a power plant capable of producing electricity at a cost of 7 mills/kilowatt hour in plants as small as 10,000 kw.

The Chugach project has been divided into three phases. The first phase covers the initial design and development. The second phase is final development and engineering design. And the final phase is construction, start-up and operation. At the end of each phase it is proposed that each of the three parties involved will have the option of determining whether results of the completed work justify the continuation of the project.

If it is decided to complete the project, the total assistance requested of the AEC will be a maximum of $18,325,000. The title to the reactor itself would remain in AEC hands.

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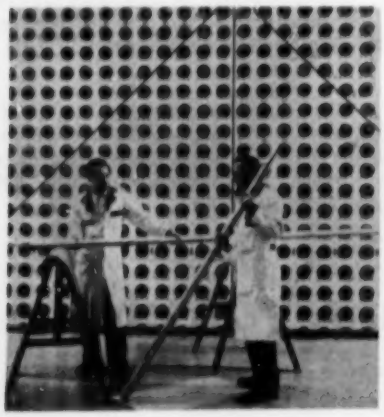
**A miniature oil refinery has been installed in the atomic pile at Brookhaven National Laboratory by atomic scientists of the Atlantic Refining Co. By means of a "loop" reactor, which permits continuous flow of petroleum samples through the pile, they are able to simulate refining conditions under the influence of atomic radiation. Here, two Atlantic men are inspecting the "loop" before inserting it into the pile.**



**A contract to design a one-cycle emergency nuclear power plant** for the Corps of Engineers' Research and Development Laboratories, Fort Belvoir, Va., has been awarded to Walter Kidde Nuclear Laboratories. It is expected that the design will be completed in about seven months. □

**Gasoline has been produced by Esso Research with the use of gamma radiation.** Esso has indicated that the work done to date has been on a purely experimental small-scale basis. But Esso is currently spending more than $1 million annually in nuclear studies. □


TURN FOR MORE NEWS ON

| | |
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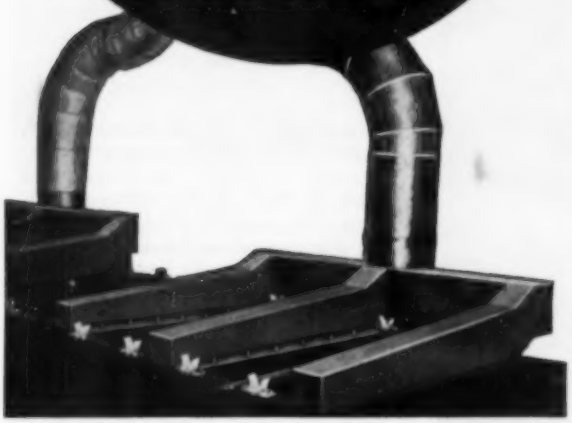
| RESEARCH | page 82 |
| NUCLEAR | page 108 et seq. |
| INDUSTRY | page 113 |
| OVERSEAS | page 123 |
| INSTITUTIONAL | page 129 |


**A new approach to the development of better petroleum products is seen by Universal Oil Products in the start-up of the world's first private nuclear reactor.** Part-owner of the Armour Research reactor, UOP expects great advances in nuclear work with petroleum. □

**Entering the radiation field, Archer-Daniels-Midland has purchased a half-interest in the Applied Radiation Corp.,** a producer of linear electron accelerators and other electronic equipment. □

**Continuing its development of a neutron generator, Tracerlab is now directing the design of this device toward use in oil well logging.** In addition to the instrument's potential use in oil well logging, Tracerlab claims the generator offers a wide variety of uses in other scientific fields. □

# AGILE'S Plastic Ductwork Costs Less... Has Longer Service Life Than Stainless Steel



## AGILE'S Plastic Installation

- Cost ..... $491.00
- Service .....Still in use after 3 years

## Stainless Steel Installation

- Cost ..... $581.00
- Service ..... only 16 months

**PROBLEM:** This company was using a type 19-9 stainless steel stack for venting the fumes on a sulphuric acid tank. This stack was installed at an original cost of $581, was no longer serviceable after 16 months because of corrosion.

**SOLUTION:** The company replaced the stainless steel installation with a plastic structure of equal dimensions for $491.00. The new stack still in perfect condition, has a life expectancy of many, many years.

Whenever you have a corrosion problem, check with American Agile. Many years of research and wide practical experience have made American Agile experts in the fields of plastics and corrosion prevention.

*For detailed information be certain to write for your free brochure . AA-4*

AGILENE AGILIDE

**AMERICAN AGILE CORPORATION**

Plant and General Offices • 5461 DUNHAM RD. • MAPLE HEIGHTS, O.
Mailing Address, P. O. BOX 168 • BEDFORD, O.



Advertisement

# Pumping Progress Report

**FOR CHEMICAL ENGINEERS**

An advertisement prepared by The Aldrich Pump Co., Member of Hydraulic Institute, U.S.A.

PUMP INSPECTION, MAINTENANCE AND REPAIR are jobs too frequently ignored by pump designers. In a survey of more than 1,500 pump installations, speed and economy of maintenance was frequently quoted as a major factor in pump selection.

SECTIONALIZED FLUID-ENDS offer an excellent means of guaranteeing both speed and economy in pump maintenance. As originated by ALDRICH Pump Co. engineers, fluid ends have only four main assemblies — the working barrel, suction manifold, discharge manifold and stuffing box.

SPEED IN MAINTENANCE comes with ease of accessibility to wearing parts. Manifolds are slid back on studs and valves removed as complete units. Split collar and flange connection of plunger to yoke permit easy removal of plunger.

ECONOMY OF MAINTENANCE comes with speed in maintenance. Even more important is the simple fact that it is cheaper to replace a single section than a complete fluid-end. When corrosive liquids are pumped, this is particularly important.

THE DIRECT FLOW PRINCIPLE, utilizing the sectionalized fluid-end, was developed by the ALDRICH Pump Co. Aldrich Engineers have become known as the people to see about your tough pumping problems. We have never turned down a challenge.

FURTHER INFORMATION can be had direct from the company. Tell us your requirements and we'll send you Data Sheets describing the pump we recommend. Address your request to: The Aldrich Pump Co., 20 Gordon Street, Allentown, Pa.

The heat transfer and process units shown are only a very few of the many designed and fabricated by Manning & Lewis Engineering Co. every year.

This confidence *must* be warranted:

Our customers have proof, from long association that their heat exchange and process equipment will be:

**DESIGNED**
*. . . for Top Quality Performance*

**ENGINEERED**
*. . . for Economy and Efficiency*

**FABRICATED**
*. . . with strict adherence to specifications and drawings*

These claims are for *US* to prove! Send us your next job for quotation.

We are accustomed to working with all ferrous and non-ferrous metals.

**Manning & Lewis**
*Engineering Co.*
32 Ogden Street Newark 4, New Jersey
SALES REPRESENTATIVES IN PRINCIPAL CITIES


## NUCLEAR NEWS

**A new $2 million radiation physics laboratory** will be constructed at Du Pont's Wilmington, Del., Experimental Station.

The new laboratory, expected to be completed by January, 1958, will be staffed by Du Pont's engineering department and will provide additional facilities for long range research on the measurement of radiation and its absorption in various materials. □

**On a single charge of uranium fuel, the prototype nuclear power plant for the atomic submarine ran 66 days and nights at full power without shutdown.** The magnitude of this can be seen if it is considered that this number of hours of full-speed operation (1600 hours) would have taken the Nautilus at full speed around the world and some distance farther without refueling. Such a trip would have used 1,600,000 gallons of diesel fuel in a diesel submarine, which, of course, the submarine could not carry. □

**The most powerful isotope radiography machine ever developed for portable field work** has been delivered to the Newport News Shipbuilding and Drydock Co. by the Nuclear Systems Division of The Budd Co. Employing the radiation from a 50-curie cobalt-60 source, the machine may be used to detect possible defects in atomic reactor shielding.

Called the Multitron, the machine is capable of penetrating very heavy sections of steel, lead and other materials. can accomplish the same job as a 2-million-volt X-ray machine, although it costs much less. Remote control allows the source to be exposed at distances up to fifty feet from the operator with complete safety. □

**Isotope Specialties Co., Inc., Burbank, Cal., has been acquired by Nuclear Corp. of America, Inc.** Nuclear Corp., one of the first companies dealing primarily in commercial peacetime uses of atomic energy, has acquired by the purchase a line of tagged chemicals including over 150 products used daily in a wide variety of industrial and investigative procedures, as well as complete facilities and staff for the synthesis of a wide number of organic and inorganic radiochemicals. □

**A nuclear research laboratory will be built by the General Atomic Division of General Dynamics Corp. on San Diego city-owned mesa land.** In a recent vote, some 85% of the voters of San Diego approved the transfer of the land for the laboratory. □

The second largest cesium-137 gamma ray source (2,000 curies) was produced in the remote control cell shown above at the Oak Ridge National Laboratory. Produced by the Union Carbide Nuclear Co.-operated laboratory, the source was made by chemically recovering the radioactive cesium from nuclear wastes, converting the cesium into dry cesium chloride powder, and pressing the powder into compact pellets. Three of the pellets were combined to make the final radiation source in the remote control cell. Cesium-137 is the most important long-lived (about 30 years) gamma ray emitting isotope found in the by-products of nuclear fission. This source will be used by the Univ. of Michigan.

**Largest and most modern plant devoted to the processing of monazite sand into rare earths and thorium** has just been built by Davison Chemical Co. Division of W. R. Grace, and its affiliate Rare Earths, Inc. The plant, at Curtis Bay, Baltimore, Md., cost $2 million since use was made of an existing building. Processing capacity is from 15 to 25 tons per day of monazite sand. Thorium will go to AEC. □

**Two loans totalling 8,000 pounds of natural uranium metal, plus neutron sources,** to be used in connection with expanding instruction in nuclear engineering, have been approved for the University of Florida and the Virginia Polytechnic Institute, by AEC. □

**AEC has issued a permit for the construction of a developmental nuclear power reactor by General Electric in Alameda County, Calif.** Located at GE's new atomic laboratory, the reactor will be a boiling water type contained in a gas-tight building, will operate initially at a power level of 3,000 kw., will use U-235 enriched uranium as fuel. □

**The first reactor to be installed at a European university for training engineering students in nuclear science** will be constructed by AMF Atomics, Inc., a subsidiary of American Machine & Foundry, for the German state of Bavaria. A research reactor, it will be built at Munich's Technische Hochschule. □


35% NICKEL

DURALOY D

15% CHROMIUM

Furnace Castings

*Here are two good examples of our work in high-nickel castings!*

These are in the Duraloy HT group calling for Ni 33.37 percent. We've gone as high as 68% nickel on some castings where extremely high temperatures and very severe corrosive conditions had to be resisted. The important factor concerning castings for exceptionally high temperatures is that they must retain their structural form under load.

Knowing just how much nickel to put in and how much chromium and other alloying elements depends to a large extent on experience . . . and it is experience that we can offer you for the castings you need. We've been producing static castings since 1922 and centrifugal castings since 1933, being among the pioneer founders in each class.

**If you would care to have our metallurgist study your casting problem, we shall be glad to have you call upon us for the service.**

*Our New General Catalog is yours for the asking.*

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## Programmed Process Weighing

**Glengarry Process Weighing Systems**—for timed, automatic weighing of dry components into the process stream—build profits, pay for themselves in a surprisingly short time.

**Precise formula control**—versatility—rapid operation.

**Customized Systems** for small and large operations. Recommended for new installations or for modernizing existing arrangements.

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The work at JPL includes a search for new propellants and new materials, and the investigation of basic concepts and processes in both chemical and nuclear propulsion.

Exceptional opportunities for original research under ideal working conditions have resulted in an effective group of scientists and engineers devoted to the attack on problems of the future.

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jpl JET PROPULSION LABORATORY
A DIVISION OF CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA


## NUCLEAR NEWS

**A large new uranium processing mill, and two smaller ore processing plants will be built by Union Carbide Nuclear Co.,** under a new contract with AEC. Union Carbide will operate the processing plant at Rifle, Colo., a few miles from its present mill. The two smaller plants will be located at Slick Rock, San Miguel County, Colo., and Green River, Emery County, Utah.

The contract to engineer, procure and construct for all three plants has been awarded to Catalytic Construction Co. □

**Continued activity of Vitro Corp. in the atomic energy field includes a new uranium mill at its present Canonsburg, Pa., location.** To cost more than $1 million, the new mill will be the first commercial primary uranium processing plant in the Eastern U. S. The new mill will also give Vitro's installation new facilities for a recently developed solvent extraction process which offers increased efficiency. The new plant will double the old facilities in size, and will allow technical and reagent grade chemical production.

Another new development at Vitro is an agreement between Vitro and Four Corners Uranium Corp. of Denver that provides, as its major part, that Four Corners will ship uranium ore from its Utah mines to the Salt Lake City mill of Vitro Uranium Co. Four Corners will start with a minimum of 3,000 tons per month and may increase to a maximum of 12,000. The agreement extends for as long as Vitro operates the Utah mill and Four Corners has minable ore bodies. □

**The Consolidated Edison (New York) nuclear power plant at Indian Point, N. Y., will have major portions designed and engineered by Vitro Corp.'s Vitro Engineering Division.** The plant, which is the first full-scale privately-financed nuclear plant in the world, will furnish the first nuclear produced electric power to New York City. □

**The hottest "hot lab" in the country will be built at Southwest Research Institute in San Antonio.** To cost $600,000, the "hot lab" will be built as part of the nuclear powered aircraft program of Pratt and Whitney being done at the Institute. The building will contain two test cells, each capable of handling up to 100,000 curies of cobalt 60, one of the most powerful sources of radiation known. The lab will be built into the side of a hill, will test the action of radiation on fuels and lubricants. □

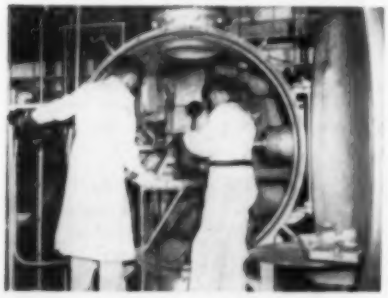
**A 2-million-volt Van der Graaff particle accelerator for nuclear research in the petroleum industry has been purchased by Magnolia Petroleum Co.** To be used in the company's Field Research Laboratories in Dallas, the accelerator was manufactured by High Voltage Engineering Corp., Cambridge, Mass.

Magnolia has already applied an earlier Van der Graaff in the analysis of elements in core samples, cuttings, crude oils and other earth specimens. □

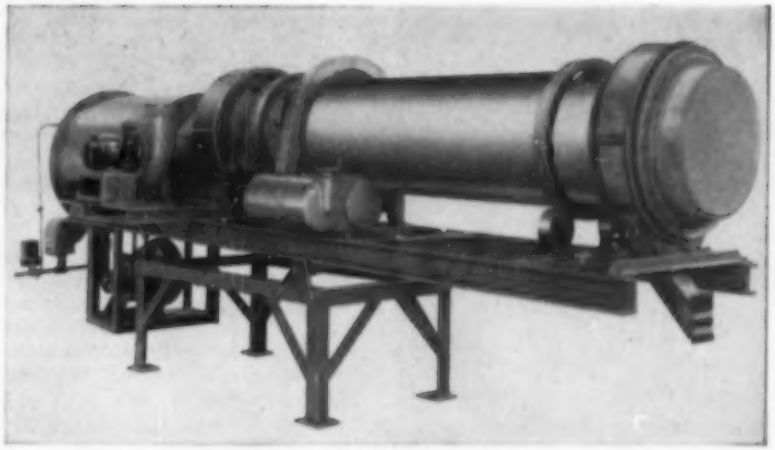
**Two loans totalling 11,000 pounds of natural uranium metal, plus neutron sources, to be used in connection with expanding instruction in nuclear engineering, will be made by AEC** to M.I.T. and the City College of the City of New York. □

**AEC has selected the proposal of Babcock and Wilcox to design, fabricate and operate a liquid metal-fueled reactor experiment,** contingent on negotiation of an acceptable contract. □

*At Lynchburg, Va., is the nation's first privately financed plant built exclusively to manufacture nuclear reactor fuel elements and related nuclear products. Highly modern, the new Babcock & Wilcox facility was built and is operated with all necessary safety precautions. Below, workmen complete a melt in the induction melting furnace used in fuel element fabrication.*



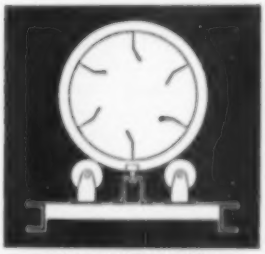
**Dravo Corp., Pittsburgh, Pa., will be installation contractor for an atomic energy reactor at Westinghouse Electric-Duquesne Light Co.'s Shippingport nuclear plant.** Dravo will start work immediately on the multi-million-dollar installation. The reactor at Shippingport is a pressurized water one, will be installed within a 200-ton pressure vessel. □

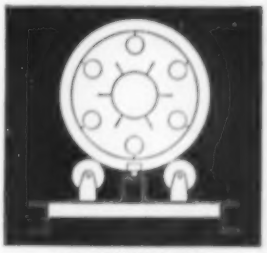
## PILOT PLANT ROTARY DRYER

The Ruggles-Coles Pilot Plant Dryer is designed especially for laboratory use or for small capacity unit operations requiring a continuous or intermittent drying step. Each unit:

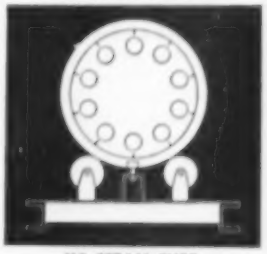
- Is mounted on a structural steel base.
- Has removable "knockers."
- Provides for easy changing of shell rotation speed or shell slope.
- Is available in stainless steel or other corrosion-resistant materials.
- Requires only fuel supply and power connections to be placed in operation.
- Is easily moved from place to place.



XH-XF SINGLE-SHELL



XB DOUBLE-SHELL



XC STEAM TUBE

**It is available in three models:**

(1) XH-XF single-shell, direct gas fired dryer. Arranged for either parallel or counter-flow operation. Bulletin AH-471.

(2) XB double-shell, indirect-heat, gas-fired dryer for drying without contamination. Volatiles removed with only limited dilution. Bulletin AH-472.

(3) XC steam-tube indirect heat dryer. Can be connected to any available steam supply or furnished with a 3-HP steam generator. Bulletin AH-473.

*For complete information write Department 40.*

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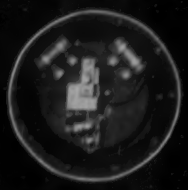

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DIAPHRAGM CONTROL
FOR LOW PRESSURES

HAS HERMETICALLY SEALED MAGNETIC MERCURY SWITCH

Here's a diaphragm operated pressure control for use on low pressure applications where the control is required to operate from changes of fractions of inches of water (pressure). It has many applications such as for operating from changes in draft conditions (either forced or induced;) to operate from slight changes in head pressure; for high or low alarm devices on air or gas lines.

OPERATING RANGES—six ranges available from 0-1" pressure to 1-30" vacuum with sensitivities varying from .01" pressure to 0.2" vacuum depending upon range selected.

CIRCUIT ARRANGEMENTS—several models available to accomplish the following operations:

*SPST—USING ONE MAGNETIC SWITCH—"switch contact opens on increase of pressure or switch contact closes on increase of pressure."*

*STAGE OPERATION—SPST USING TWO MAGNETIC SWITCHES—"open both switch contacts on increase of pressure"; "close both switch contacts on increase of pressure"; "close one switch on increase another on decrease"; "open one switch on increase another on decrease".*

CASE STYLES—three types to meet following conditions: Indoor (general purpose), Outdoor (weather resistant), and Hazardous Locations (explosion proof).

**WRITE FOR BULLETIN No. 13**

**THE MERCOID CORPORATION**
**4201 Belmont Ave., Chicago 41, Ill.**

*Manufacturers of controls for pressure, temperature, liquid level, float, mechanical operation, etc. All equipped with hermetically sealed mercury contacts.*

## NUCLEAR NEWS

**A $2 million contract for the engineering and construction of the largest pressure vessel of its type ever built** has been awarded to New York Shipbuilding Corp. by General Electric. The vessel, a welded steel atomic reactor tank, will be used at GE's 180,000-kw Dresden nuclear power station near Chicago. The vessel will have a 12-ft. 8-in. inside diameter, an approximate height of 42 ft., and will stand upright inside a steel sphere 190 ft. in diameter. When filled, the vessel will hold some 278,000 lbs. of water. □

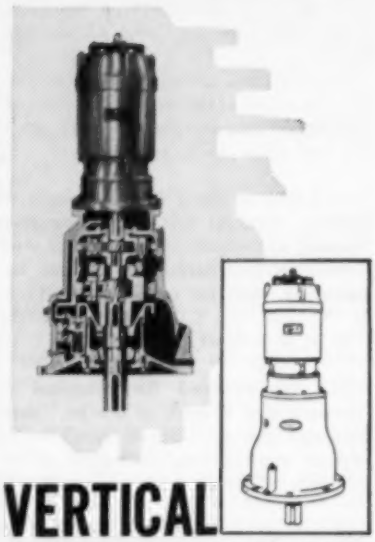
**The accumulation of material resulting from the rapid growth of unclassified research in the atomic energy field** has made it necessary for the American Nuclear Society to hold a winter meeting, December 10-12, at the Sheraton-Park Hotel, Washington, D. C. Authors desiring to present papers at the meeting are requested to send titles and estimates of presentation time to Dr. L. D. P. King, Los Alamos Scientific Laboratory, P.O. Box 1663, Los Alamos, N. M., by October 1. □

**Step-by-step aid to engineers and scientists in designing reactor shielding is contained in a manual of techniques** and data published recently by AEC and made available to industry through the Office of Technical Services, Dept. of Commerce. □

**A low-level beta counter for routine radiochemical measurements** has been developed by Isotopes, Inc., Westwood, N. J. A low-background counter, the instrument will measure all but the softest beta emissions. □

**Welders put the finishing touches on steel shell for the vapor container of the Army Package Power Reactor which ALCO Products, Inc. is building for the AEC at Fort Belvoir, Va. Expected to be in operation early in 1957, the reactor's vapor container is 64 feet high and 36 feet in diameter, with walls of ⅞-inch steel plate that will be reinforced with two feet of concrete. Being built under the first price-fixed contract awarded by AEC, the reactor is a 2000-kw. pressurized water type designed so that components may be carried anywhere in the world by air and assembled at the destination.**

*Philadelphia*
**MOTOREDUCER**



**VERTICAL SHAFT DRIVE**

For a compact, neat and sturdy self-contained Vertical Speed Reducer, the Philadelphia **MotoReduceR** is tops in design, construction and operation. The unique single casing and bolted-on motor construction . . . makes mounting and installation very simple, and of course, it eliminates base plates and couplings. The planetary, in-line reduction gears provide a rugged drive capable of withstanding severe overload conditions . . . Other features are: wide bearing span, permitting use of long, unsupported vertical shafts; Exclusive "dry-well" construction, which prevents oil leaking down output shaft.

Philadelphia MotoReduceRs can be supplied for output speeds from 9 R.P.M. to 420 R.P.M. with standard motor speeds . . . Units up to 100 H.P. are available—and a full range of horizontal units can also be supplied.

For complete information, send for 32 page Catalog MR-54

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Virginia Gear & Machine Corp. • Lynchburg, Va.

## UREA PLANT USES NEW PROCESS

**New urea plant of Standard Oil Co. of Ohio on-stream at Lima, O., is first plant in country to utilize the Inventa-Vulcan process.**

Part of Sohio's $18 million petrochemicals installation at Lima, the new urea synthesis plant was designed and built by the Vulcan Engineering Division of Vulcan-Cincinnati, Inc. (formerly Vulcan Copper & Supply Co.), to use the Inventa-Vulcan process. This process is the Inventa process developed at the urea plant of Holzversuckerungs, A.G., Switzerland. Vulcan licenses the process in this country and Canada.

According to Vulcan, the process is characterized by simplicity of design, ease and flexibility of operation, and high purity of product. As evidence, Vulcan points to the fact that within six hours after start-up, the Sohio plant was producing high quality urea with no clogged lines or contamination.

The latter is of particular significance since one of the traditional problems in urea synthesis has been corrosion. Vulcan claims that the new process eliminates corrosion, and the fact that metal content of Sohio's product is less than half of rigid industrial specifications would tend to back the company's claim.

In the prilling operation at Sohio, Vulcan has used a design and operation basis for the tower that comes from Friederick Uhde GMbH of Dortmund, Germany.

As part of the $57 million capital expenditures program for improvements of plants, equipment and processes during 1956, Eastman Kodak has built this giant outdoor distilling column for distilling out solvents of high purity at its Kodak Park Works in Rochester, N. Y. In the picture, heavy duty cranes combine their power to lift the 7-ton top section into place.

Up she goes!...at Sinclair's new UDEX Plant built by Badger Manufacturing Company.


**42-ton stripper...by Downingtown**

**Diameter: 6' I.D. • Total Height: 133' 3" • Shell Thickness: ¾"**
**Material: Carbon Steel • Total Weight: 42 tons • 40 Bubble Cap Trays**

Fabricated at DOWNINGTOWN IRON WORKS for Badger Manufacturing Company. Stress relieved...spot X-rayed...Code stamped. Field erected by Badger Manufacturing Company at UDEX Plant of Sinclair Refining Company, Marcus Hook, Pa. Send for Bulletin PF and learn more about Downingtown engineering experience and fabricating skill.

**Downingtown Iron Works, Inc.**

HEAT EXCHANGERS—STEEL AND ALLOY PLATE FABRICATION

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**thorium**

OXIDE
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AND OTHER SALTS

**neutron absorbers**

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World's largest
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## INDUSTRIAL NEWS

**A process that beams two-million-volt electrons at a silicone gum and almost instantly converts it into silicone rubber** has been devised by Westinghouse Electric. The three scientists who discovered it say that the process produces a better rubber in two seconds than conventional vulcanizing methods yield in several hours. □

**Experiments conducted in the past two years in South Texas indicate that treating the soil with trace minerals molybdenum,** copper and zinc stimulates the growth of legumes and may increase forage production sufficiently to be of economic importance to the area. □

**A contract to design and install new cuprous chloride manufacturing facilities for the Henry Bower Mfg. Co.** in Philadelphia has been awarded to Brown, Blauvelt and Leonard, consulting engineers of New York. The new facilities will produce a high purity product. □

**Industrial steam turbine generator manufacturing capacity, and mechanical drive turbine capacity, is being expended by General Electric** at the company's Lynn, Mass., plant. Expansion and modernization will take five years, will cost $23 million. □

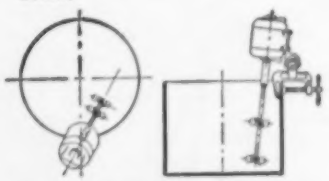
**The price of pure silicon has been reduced $30 a pound by Du Pont.** New price will be $350 a pound and the company is planning new facilities to meet increasing demand. □

**The new steel and titanium chemical milling pilot plant at Turco Products is designed to serve three purposes. It will serve as a research center for development of new techniques in the chemical forming of steel and titanium. It will also be used for the preliminary forming of prototype parts for prospective users of Turco's process. And it will help train personnel of sublicensees. The pilot plant, which is a joint effort with North American Aviation, duplicates actual production conditions.**

# MIX LIQUIDS in any container

You can do hundreds of mixing jobs at low cost. You can get rapid, uniform mixing in no time at all with an Alsop Portable mixer. It's easy to clamp in place on any open vessel. You can easily and quickly adjust it to the correct mixing angle—service many different operations in various places throughout your plant.

Many models to choose from—sizes 1/20 to 7½ H.P. in your choice of motors and materials of construction. Send for Alsop Mixer Catalog today—use coupon below.



Portable Mixer Mounting Assembly allows effortless adjustment up and down and right or left to any angle for the mixing action your process might require.

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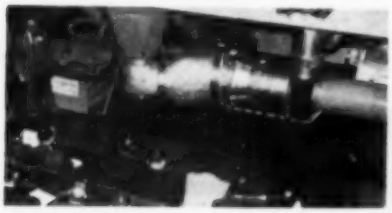
MAIL COUPON NOW!

## INTRODUCE 1130 BHP GAS TURBINE

**Clark Bros. propose gas turbine as combustion chamber for process heat with low-cost power takeoff from shaft**

Use of a gas turbine power drive as a combustion device feeding a process steam waste heat boiler can offer fuel thermal efficiencies as high as 85%. This is the substance of a proposal being made to the petroleum refining and chemical processing industries by Clark Bros. Co. of Olean, N. Y., soon to start production of the Mark TA gas turbine. The unit will be built under license from Ruston-Hornsby Ltd., of England, which has more than 40 installations of this type in industrial operation throughout the world.



*Industrial leaders watch a demonstration run of Clark Bros.' Mark TA gas turbine at a recent showing in the company's Olean, N. Y., plant.*

Developing 1,130 bhp, the Mark TA has a nominal output turbine speed of 6,000 rev./min. Through the use of built-in planetary gears, output speeds of 1,500 and 1,800 rev./min. are available for driving 50- or 60-cycle generators.

Continuous commercial operation for more than 3,000 hours has shown that the unit requires practically no maintenance—on inspection no significant wear was found.

#### Chemical Process Applications

If the turbine is used for power only, without recovery of exhaust heat, efficiency is approximately 15%. Cost of the Mark TA is stated to be $110,000, or about $100 per hp. A comparable diesel installation would probably be in the range of $60 to $70 per hp.

However, by use of a waste heat boiler, over-all thermal efficiency can be increased to about 70% and, if additional fuel is burned in the exhaust stream, efficiencies as high as 85% are claimed. Application in the chemical industry would seem to be indicated for processes which demand process steam as well as electric power. Exhaust heat could also be used for other process purposes such as preheating.

At least one process application of a comparable turbine of larger size has been made to an operating nitric acid plant in the United States.


*Now* *simpler, more accurate control of oxygen in*

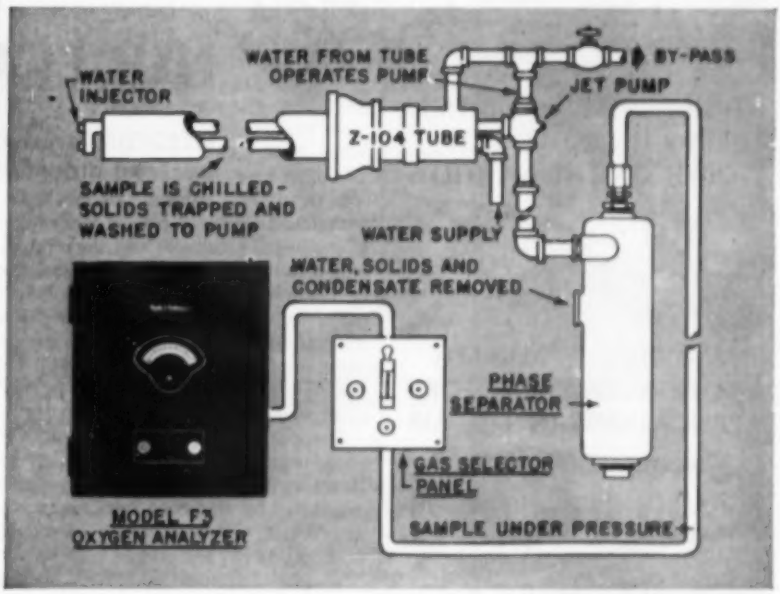
**BOILERS...FURNACES...KILNS...DIRECT-FIRED HEATERS, ETC.**

*with* Arnold O. Beckman INC

**complete Analysis Systems!**

Arnold O. Beckman, Inc. – leaders in developing advanced instrumentation for accurate oxygen control – now offers *complete* analysis systems for higher combustion efficiencies at lower fuel costs.

These field-proven systems are already being used by progressive operators to boost profits, cut costs – and they will make the same savings for *you*. They consist of Analyzer, and Sampling System – all in one compact installation suitable for indoor or outdoor location. For severe temperature conditions, heated cabinets can be supplied.




The diagram (above) shows a typical analysis system for boilers. The incoming sample gas is first chilled and washed . . . then passes through a Separator where the condensables and solids are removed. The resulting clean, dry sample gas flows under pressure to the Gas Selector Panel (for selecting "Zero," "Span" and "Sample" gases) . . . then into the Analyzer where the oxygen content is quickly measured. The Analyzer may be used with any standard recorder or controller.

*Result* – new speed, simplicity and accuracy in controlling air-fuel ratios, with important savings in fuel and operating costs!

*Get the full story* on these Complete Analysis Systems by writing for Data File #19A-96.

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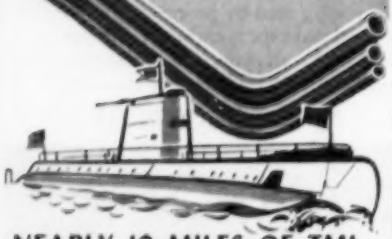
TMI STAINLESS STEEL TUBING HAS

Atomic Experience!



NEARLY 10 MILES OF TMI TUBING IS PROVING ITS WORTH ON THE NAUTILUS!

TMI TUBING IS ALREADY UNDER ACTIVE TEST FOR APPLICATIONS IN THE AIR!

TMI TUBING IS BASIC IN AMERICA'S FIRST COMMERCIAL NUCLEAR ENERGY ELECTRIC POWER PLANT!

The Mark of Quality TMI

• *TMI's Atomic Experience is at your service from the initial plans to the final proven specifications. Specializing in stainless steel and special alloy tubing—in small diameters, .050" to .625" O.D. with tolerances as close as .001" when required.*

**TUBE METHODS INC.**

METALLURGISTS • ENGINEERS • MANUFACTURERS

BRIDGEPORT (Montgomery County), PA.

In a paper presented before the recent A.I.Ch.E. National Meeting in Detroit, R. M. Boarts, professor of chemical engineering, University of Tennessee, emphasized the present need for three types of engineers:

• 1—Design engineers capable of carrying out all phases of reactor design. Such men cannot be produced by undergraduate courses. They must have a solid grounding in at least one branch of engineering plus additional mathematics and specific training in advanced nuclear theory and practice.

• 2—Engineers in nuclear technology other than design, such as fuel reprocessing or radiation problems. Here a chemical engineer with a modest amount of additional study is sufficient.

• 3—Engineers to do work in nuclear installations which would not be essentially different from the work they do in other industries.

Of these three categories, by far the greatest demand is for the first type, which might be called the truly "nuclear" engineer.

In this fact lies a major problem of education for nuclear engineering. While the universities can, and do, turn out engineers for the second and third categories, they cannot, for the most part, train the first type as yet. This job is in the hands of the National Laboratories and industry.

The future of the entire industry rests with solving the problems of adequately training engineers for the nuclear field.

# NUCLEAR TRAINING

**NEEDED: Three types of engineers for nuclear industries.**

Presidents and deans of accredited engineering colleges and universities, plus leading nuclear educators, gathered at Gatlinburg, Tenn., September 5 to thrash out problems of accelerating the training-preparation for men to man our nuclear installations and accepted in principle $3 million plus in "no-strings" Government aid.

Purpose of the Gatlinburg Conference, organized by AEC's Division of Reactor Development and suggested originally by the American Society of Engineering Education, was to provide an opportunity for college and university administrators and AEC educational personnel to discuss programs of education and training for science and engineering students planning a nuclear energy career. The Conference served also to enable the AEC to launch its proposed "aid to the universities" program which is backed by more than $3 million (for 1957).

### AEC Announces Program of Aid to Universities

A large-scale program is planned by the AEC Educational and Training Program, Division of Reactor Development. Prime movers and chief administrators of the AEC program are John F. Kaufmann, Chief of the Technical Assistance Section, Division of Reactor Development, and Harold L. Walker, for many years head of the Department of Metallurgy, University of Illinois.

### Budget Authorized

In February, 1956, an appropriation of $5,583,000 was approved by Congress for the fiscal year 1957.* Proposed breakdown is as follows:

| | |
|---|---|
| 1. Faculty Training | $450,000 |
| 2. Student Assistance | 450,000 |
| 3. Traveling Lectureship | |
| 4. Engineering Open House at National Labs | |
| 5. Assistance to Colleges (Equipment and Teaching Aids) | 3,000,000 |
| 6. Nuclear Materials | 400,000 |
| 7. Other Assistance | 350,000 |
| 8. School of Nuclear Science and Engineering (ANL) | 650,000 |
| 9. Oak Ridge School of Reactor Technology | 283,000 |
| Total | $5,583,000 |

### TEACHING ONLY—NO RESEARCH

Of the above budget breakdown, items 5 and 6 apply most directly to the "aid to the universities" program. Typical types of training and demonstration facilities which the AEC will provide are:

**Subcritical and training reactors.**

**Radiation detecting, monitoring and counting.**

**Similation of reactor heat transfer.**

**Demonstration of material compatability.**

* **A grant to an institution may not exceed $350,000. Byproduct nuclear materials will be available at 20% of list price, other nuclear materials on loan but not to exceed $50,000 in value.**

**Chemical processing of fuel materials.**
**Analysis for U, Th, Pu and fission products.**
**Waste disposal & hazards.**
**Reactor simulators.**

No assistance will be given for the purchase of land or the erection of buildings. In general, the equipment to be furnished will consist of laboratory demonstration units for teaching purposes only. It is not the intention of the program to provide pilot plant units for research or development. The equipment will constitute an outright grant to the colleges and universities involved.

### Over-all Objectives of AEC Program

AEC Commissioner Willard F. Libby, in addressing the conference, stated objectives of the over-all educational program as:

1. **Partially fulfilling the AEC's manpower requirements in nuclear energy technology.**
2. **Assisting colleges and universities in filling their expected roles in nuclear education and training.**
3. **Filling temporary gaps in the Nation's industrial requirements for trained personnel.**

It is emphasized that the AEC is not an educational institution, has no charter or mandate to serve as such, and does not propose to become one.

### Conference Program

Sessions started with several papers outlining the present need for trained personnel in Government as well as in private nuclear energy programs. An entire day was devoted to the educational programs of the Oak Ridge and Argonne National Laboratories. Other papers covered educational work being carried out in the universities. Speakers included members of the AEC and its National Laboratories and representatives of private industry and educational institutions.

### Educational Opportunity for Practicing Engineers

One of the special provisions of the Plan will benefit the engineer now employed in industry. This is the doubling of the training program at the Oak Ridge School of Reactor Technology (ORSORT).

ORSORT is a graduate level school offering to both the engineer and the scientist advanced training in the design, construction and operation of nuclear reactor systems. At the present time, the entire one-year course is given at the Oak Ridge School.

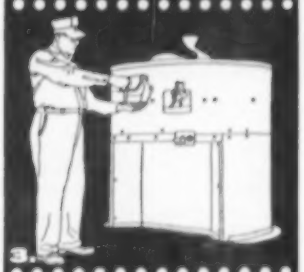
Beginning about March, 1957, stud-

(*Continued on page* 119)

**Here's why MIX-MULLER® is today's BEST BUY in MIXING EQUIPMENT**

1.

2.



3.

4.

The advantage of preparing dry, wetted or plastic materials in a Simpson Mix-Muller is written in *savings*. Controlled mixing *cannot fail* to result in effective utilization of raw materials. Adequate control over moisture, alone, can mean the difference between an unwieldly reject ratio and a profitable mixing operation. See how these four outstanding features of the Simpson Mix-Muller are designed to save you time, labor, material, power, maintenance and *money*:

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**2. SPRING LOADED MULLERS** . . . allow muller pressure to be adjusted to the type and density of materials to be mixed. You reduce mulling time, build desired properties faster.

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**4. MOST THOROUGH MULLING ACTION EVER DEVELOPED.** Thorough dispersion affords high yield of even trace elements and optimum utilization of mixing properties. High muller pressure to area ratio (see chart) assures *most* mulling per revolution.

WRITE FOR Bulletin on "Mulling for the Chemical & Process Industries" *today!*

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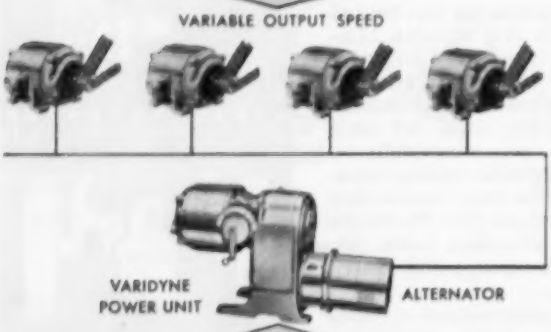
**...a simple means for simultaneous speed variations**

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# CANDIDATES FOR MEMBERSHIP IN A. I. Ch. E.

The following is a list of candidates for the designated grades of membership in A.I.Ch.E. recommended for election by the Committee on Admissions.

These names are listed in accordance with Article III, Section 8, of the Constitution of A.I.Ch.E.

Objections to the election of any of these candidates from Members and Associate Members will receive careful consideration if received before October 15, 1956, at the office of the Secretary, A.I.Ch.E., 25 West 45th Street, New York 36, N. Y.

## Associate Member

Aldred, Alfred H., *Jr., Nashville, Tenn.*
Allen, Frank C., *Jr., New Orleans, La.*
Allen, Robert S., *Stamford, Conn.*
Bahr, Franklin A., *Weiser, Idaho*
Barbee, Jack W., *Beaumont, Tex.*
Barrett, John E., *Jr., Pensacola, Fla.*
Baumann, James E., *San Francisco, Calif.*
Blaisdell, John L., *Amherst, Mass.*
Blaustein, Milton, *Brooklyn, N. Y.*
Bowman, Walker H., *Whiting, Ind.*
Boyd, David M., *Brownsville, Tex.*
Brooks, William T., *Chicago, Ill.*
Brown, Joseph L., *Vienna, W. Va.*
Daggett, Samuel H., *Jr., Orange, Tex.*
Darst, William E., *Louisville, Ky.*
Davis, William Ray, *Atlanta, Ga.*
Edenbaum, Martin I., *New Brunswick, N. J.*
Epstein, Michael M., *Columbus, Ohio*
Finney, Garnet R., *Nashville, Tenn.*
Fleck, Edwin G., *Jr., Havertown, Pa.*
Galanti, Anthony, *Berwick, Pa.*
Galletti, Robert L., *Los Angeles, Calif.*
Gatchell, Paul R., *Midland, Mich.*
Georgiou, Constantinos, *Wilmington, Del.*
Gilbert, Sheldon S., *New York, N. Y.*
Goldstein, D. J., *McMasterville, Que., Can.*

(Continued on page 120)


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**Use on all Gears not running in Oil**

**Absolutely Nothing Else Like It!**
**OUTLASTS ORDINARY LUBES 5-to-1**
**Sticks to Metal**

1. **ECONOMICAL**—Spray container reduces lubrication time. Long lasting film. One can covers approximately 25 sq. ft. of surface with no waste.
2. **HEAVY DUTY**—The finest extreme pressure adhesive lubricant there is for open gears.
3. **EASY-TO-USE**—No fuss . . . no muss. Ease of application encourages and assures complete lubrication of open gears.
4. **CLEAN**—No drip . . . no throw off . . . no clean up of excess lubricant. Will not drip in hot or steamy areas.
5. **SPRAY**—Assures perfect lubrication even to the most hard-to-get-at areas.
6. **HANDY**—Marla Spray Lubricant can be carried easily and is always ready for use. Eliminates the brush, paddle or any preheating.
7. **VERSATILE**—A superior lubricant also for cams, reciprocating actions, mono rails, guides, chains, sprockets and cables.

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## NUCLEAR TRAINING

(*Continued from page 117*)

ents accepted for ORSORT will take the first six months at approved colleges and universities and the second six months at ORSORT. The college and university phase of the course will be unclassified while the six months at ORSORT will cover classified subjects and will be concentrated to take advantage of the unique facilities and the latest technology available at Oak Ridge.

By this split system, the number of students accepted per year can be increased from the present 120 to 240.

#### How to Get Into ORSORT and ANL

Applicants for admission to ORSORT may be sponsored by the Commission, its contractors, other Government agencies and their contractors, and *industrial organizations* having an active interest in development of reactors or reactor components. To qualify for entrance a student must generally have at least a B.S. degree in science or engineering with a high scholastic record. In the case of students who are regularly employed by a private industrial firm, it is expected that tuition ($2,500) and other expenses will be borne by the employing company. No strings will be attached to any graduates of the school and students from industry will be free to take back to their companies the knowledge and know-how gained during their year of study.*

The International School of Nuclear Science and Engineering was established at Argonne in March, 1955, primarily to fulfill certain commitments under the President's Atoms for Peace Program. At Argonne about 75% of the students are foreign nationals.

In April, 1956, the Argonne program was changed to provide for the participation of Pennsylvania State University and North Carolina State College, both of which have nuclear reactors. Under the revised plan, students take one semester of work at Penn State or North Carolina State and the second at Argonne. Tuition is $2,000.

#### On the Job Training

At Brookhaven, Argonne, Oak Ridge, and certain other national laboratories, industrial employees are gaining specialized experience through temporary work project arrangements. Participants from industry may either receive their regular salaries from their companies or, in

* Inquiries should be directed to: Dr. H. M. Roth, Director, Research and Development Division, U. S. Atomic Energy Commission, P.O. Box E, Oak Ridge, Tennessee.

(*Continued on page 121*)


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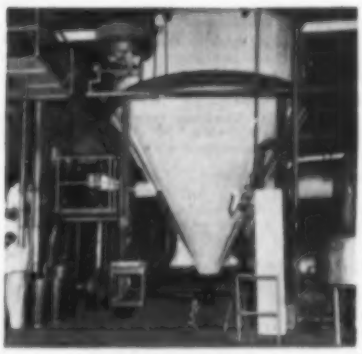

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**Our plant incorporates:**

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We invite you to take advantage of the great savings in expense, time and labor that are possible through using this Nerco-Niro service.

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For more information return the coupon below.

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**Preparation equipment**
1—1955 Model Victory Beater—for treating fibrous material, refining and preparing—complete with 400 HP and controls—fully push-button automatic.

**Forming Machine**
1—1955 Model Machine for forming fibers with incorporated resins into continuous sheets, 126" wide slitting and trimming into panels—all automatic—complete with electronic controls—motors—pumps, etc.

**Automation System**
1—American Mfg. Automation System for automatically handling the above panel boards on 24 second cycle. Complete with suction equipment—motors—controls. This system feeds the panel boards to hydraulic presses below.

**Hydraulic 15 Opening—Hot Plate Presses**
Two—1200 Ton HPM Presses—size 100" x 120". Each press handles 15 sheets of panel board at one time—with automatic loaders and unloaders—each press has 8 cylinders—200 psi—with pumping units—200 HP motors, etc.—all complete.

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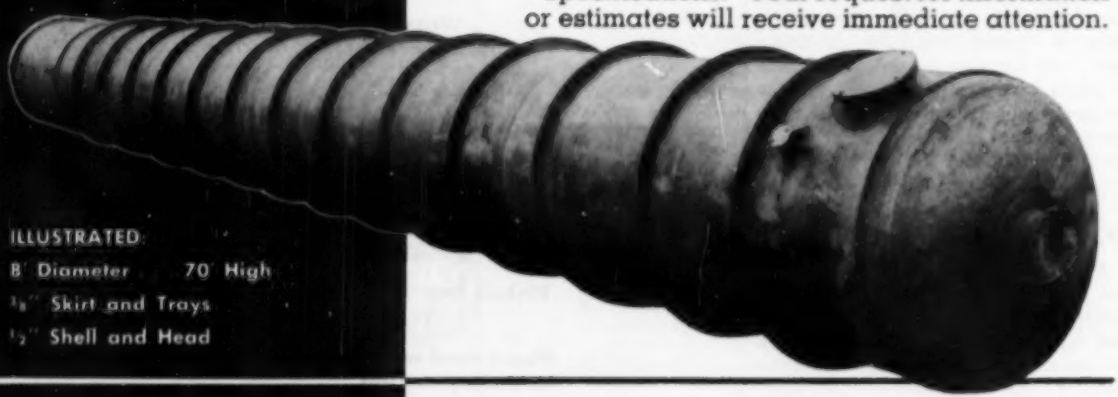
## CANDIDATES

(*Continued from page* 118)

*Gordon, John S., Dayton, Ohio*
*Hoeske, Don C., Louisville, Ky.*
*Hayden, Kenneth D., Richland, Wash.*
*Huffman, Robert J., Dallas, Tex.*
*Humphrey, Donald W., Whiting, Ind.*
*Hurt, Lewis J., Old Hickory, Tenn.*
*Inbody, Gerald W., Lincoln, Neb.*
*Irwin, Dousey B., Arlington, Va.*
*Jackson, Henry E., Chattahoochee, Fla.*
*Katucki, George A., Brooklyn, N. Y.*
*Keller, Harry N., Baltimore, Md.*
*Kirkman, Burton L., Richmond, Va.*
*Knowlton, Gwenita E., Stonington, Me.*
*Konopinski, Virgil J., Toledo, Ohio*
*Lieberman, S. Jack, Edison, N. J.*
*Lobsinger, Ralph J., Richland, Wash.*
*Loehr, Clifford Edward, Somers, Iowa*
*Matthews, Robert L., Dayton, Ohio*
*McCartney, Alan J., Midland, Mich.*
*McFarland, Harry D., Stillwater, Okla.*
*McGuire, Jimmie L., Elk City, Okla.*
*McKinstry, Donald G., Van Nuys, Calif.*
*Morenberg, Allan, New York, N. Y.*
*Murphy, Robert F., Park Forest, Ill.*
*Neville, Gordon H., Birmingham, Ala.*
*O'Bryan, Henry M., Niagara Falls, N. Y.*
*Oubre, Robert R., Freeport, Tex.*
*Pattie, Barton D., Jr., Waynesboro, Va.*
*Pillow, Sidney J., Houston, Tex.*
*Potts, Larry D., Athens, Ga.*
*Rabke, R. F., Jr., Baton Rouge, La.*
*Reider, Jack R., Baker, Ore.*
*Reynolds, Robert. Scotia, N. Y.*
*Roe, Thomas J., Anchorage, Ky.*
*Rotella, Joe P., Nashville, Tenn.*
*Royce, Frederick H., Port Angeles, Wash.*
*Sahlin, Le Roy B., Two Rivers, Wis.*
*Schrage, F. Eugene, Riverside, Ill.*
*Simms, David R., Webster Groves, Mo.*
*Smith, Alan T., Overland, Mo.*
*Smith, Lee W., Columbia Falls, Mont.*
*Tate, Wilson C., Jr., Madison, Tenn.*
*Thomasson, R. L., Texas City, Tex.*
*Townsend, Clarence R., Whittier, Calif.*
*Troy, Michael, Pittsburgh, Pa.*
*Tse, Harold, Columbus, Ohio*
*Vance, William H., Seattle, Wash.*
*Warschky, Donald, Whiting, Ind.*


# POSEY FRACTIONATING TOWERS

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## NUCLEAR TRAINING

(*Continued from page* 119)

some cases, may be attached to the staff of the Laboratory.

Such "on-the-job" arrangements benefit the Commission programs by bringing in specialized talents not otherwise available to it. On the other hand, individuals involved in this type of program receive invaluable training opportunities.

Industrial personnel have been participating in increasing numbers in programs of Commission contractors. The period of participation averages one year. During the last year, 38 engineers and scientists completed participation of this type and 65 are now taking part. So far, some 53 different industrial firms have benefited.

---

**The Special Training Division of the Oak Ridge Institute of Nuclear Studies has announced a partial list of courses** to be offered through March, 1957.

Basic four-week courses in the techniques of using radioisotopes will open October 22, 1956, January 7, 1957, and February 4, 1957.

Two-week courses in veterinary radiological health for members of the armed forces veterinary corps will open October 1 and December 3, 1956; and March 4 and March 18, 1957.

Additional special courses will be announced as they are scheduled. □

**The three-day Tracerlab symposium on applications of radioactivity in research and refinery operations** of the petroleum industry will be held in Boston at the Hotel Statler Oct. 24 through 26. □

**The 24th Annual Meeting of the Engineers' Council for Professional Development will be held in Detroit October 25 and 26.** Among the sessions will be a panel discussion on the First Five Years of Professional Development, a panel on Professional Identification and Integration into the Community, committee meetings and reports, and talks by leading engineers in the field. □

**More than $36 million has been earmarked by the University of Pittsburgh over the past five years for a building program** that is one of the most ambitious in educational history. Begun in 1951, much of the construction is now complete or well underway. Already built and occupied are the $1.5 million Engineering Hall, the $4.5 million Residence for Nurses, and the $1.5 million Memorial Field House. □

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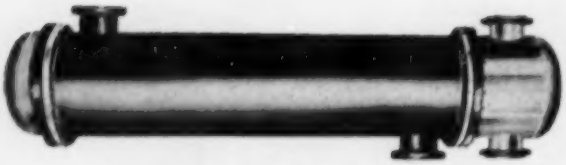

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## INDUSTRIAL NEWS

This mobile laboratory Field Test Truck of Shell Development Co. was designed to fulfill the need for obtaining first-hand technical information on refinery and chemical plant processes and their control systems. The information is then used to troubleshoot, to recommend modifications in existing plants, and for designing better process control systems for new plants.

Bringing the laboratory to the plant site isn't new to Shell Development engineers, but the new field test unit is a vast improvement over former methods of on-the-spot data gathering. Up to 14 records can be made on the equipment in the truck. The influence of normal day-to-day variations in a process will in this way be held to a minimum and the data processed faster and more accurately.

**The output of industrial gases will be doubled at Air Reduction Sales Co.'s Butler, Pa., plant,** when a new standardized steel building to house new equipment is erected by Luria Engineering Co., Bethlehem, Pa. The 8,680-square-foot building, fabricated at Luria's Bethlehem plant, is now being erected for the Air Reduction Co. Division, and the new facilities are expected to be in full operation late this year. □

**New polymerization plant with an initial annual production of 10 million pounds of polyvinyl acetate** has just been opened by the Polyco-Monomer Department of Borden Co.'s Chemical Division at Demopolis, Ala. □

**In an effort to bring out the best possible ideas of how industry can encourage students to go into careers in science and engineering,** Victor Chemical Works is sponsoring a country-wide competition that calls for submitting plans, in not over 500 words, on "The kind of program you think industry should adopt to stimulate the interest of high school graduates in becoming scientists and engineers."

Twenty suggested programs will be selected, and each winning author will have the right to nominate a 1957 high school graduate for a four-year, $4,000 scholarship in science or engineering. Of these twenty, four will win the actual scholarships. □

## OVERSEAS NEWS

**The first plant of newly formed Habib-General Ltd. of Karachi, Pakistan (joint company 60% owned by General Mills and 40% owned by Habib Brothers Ltd. of Pakistan),** will be a guar gum producing installation at Karachi. General Mills has operated a guar gum plant at Kenedy, Texas, since 1952, but has been unable to serve foreign markets because of unfavorable dollar exchange rates and import restrictions in many countries. Pakistan is an ideal site for a guar plant since the country is a major producer of guar beans and has a free trade relationship with many nations. □

**Manufacture of "Freon" refrigerants and aerosol propellents will begin early next year at Du Pont do Brasil, S.A.—Industrias Quimicas'** new plant near Barra Mansa in the state of Rio de Janeiro, Brazil. The company is a wholly-owned subsidiary of Du Pont. □

**Work has already started on a plant to produce antibiotics, other pharmaceutical products and animal feed supplements at Latina, Italy.** The plant will be built and operated by Chas. Pfizer & Co. Completion is scheduled for spring, 1957. □

**Thirty-five countries had industrial exhibits at Poland's 25th International Fair at Poznan.** A major feature of the fair this year was an International Book Fair with 500 publishers from twenty nations including France, Great Britain, Austria and the United States. Most prominent at the book fair were scientific and technical publications. □

**A 14,000 ton/year anhydrous ammonia plant has been engineered and designed for Israel** by the Chemical Construction Co., New York. Chemico personnel supervised erection and start-up of the plant. □

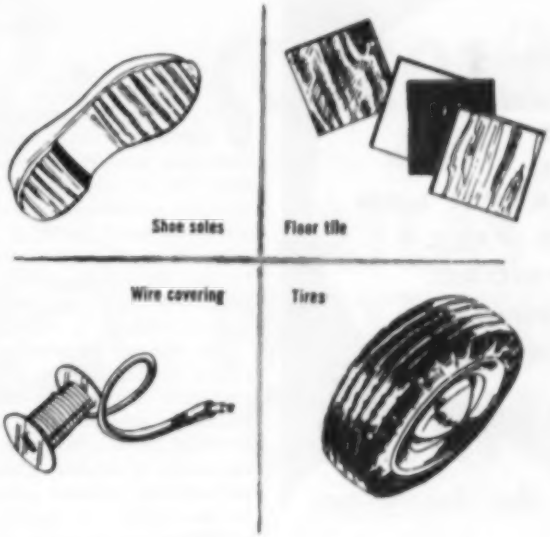
**The new Journal of The British Nuclear Energy Conference is now available.** Published three times this year, and quarterly in the future, subscription price for non-members of the British Constituent bodies is approximately $8.50 (3 pounds). □

**A plant for the manufacture of Acrilan acrylic fiber to cost $10 million** will be the first phase of construction undertaken by Chemstrand Ltd., a subsidiary of Chemstrand Corp., at Coleraine in Northern Ireland. Design plans for the plant are nearing completion, production is expected not later than January, 1959. □


# PANAREZ

## HYDROCARBON RESINS

*improve products like these*

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Compounds containing Panarez resins show **IMPROVED COLOR AND COLOR STABILITY . . . IMPROVED EXTRUDABILITY . . . IMPROVED FLEX CRACK PERFORMANCE and ABRASION RESISTANCE . . . IMPROVED OZONE RESISTANCE . . . IMPROVED TEAR RESISTANCE, TENSILE STRENGTH and ELONGATION.**

*No change in compounding technique is required when switching to Panarez resins.*

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Northampton, Massachusetts

# what's being done about NUCLEAR RISKS

**Although action seems to be coming along slowly toward an insurance program to cover fully all risks associated with operating a nuclear facility, the fact is that such a program now seems assured for inauguration well ahead of the time that the first privately licensed projects will be ready for operation.**

*Mathew M. Braidech*

National Board of Fire Underwriters
New York, N. Y.

One of the last major deterrents to commercial nuclear power development may soon be removed. All interested parties are generally agreed in principle on the solution to the difficult and complicated matter of providing insurance coverage to protect the industry and the public against damage and liability in the event of any unfortunate nuclear mishap. A real impetus and a "break-through" toward an early solution of the high ($100 to $500 million) protective coverages, which posed obstacles to private enterprise, has been provided by the special committee of top executives of leading stock and mutual property and casualty groups appointed by the A.E.C. in March, 1955. This committee's preliminary progress report paved the way for significant developments by way of a joint government-private insurance program.

### Pool Formed

One of these was the formation of three separate insurance syndicates . . . NEPIA, NELIA, and MAEP . . . which are offering a maximum private insurance coverage ranging from $65 million to $115 million—$50 million in fire and property damage on plant facilities and $50 million on public liability on each reactor, with another $15 million policy for either liability or property damage. This $115 million will be made available to an individual atomic operation and will include all insurable interests combined (contractors, suppliers of component parts, etc.) up to that figure. This protection is four times larger than any individual coverage ever written (and far above the $10 million ceiling on a chemical plant, considered one of the most risky types of industrial coverages). Nevertheless, in the opinion of the AEC, the $115 million will still be inadequate to cover a conceivable—though unlikely—reactor catastrophe of major proportions.

### NEPIA

Physical property damage insurance requirements of nuclear reactor installations and certain related facilities in the U. S. and its territories and possessions will be met by NEPIA, or Nuclear Energy Property Insurance Assn., organized in May of 1956 by 155 stock property insurance companies. Commitments to date indicate an underwriting capacity of approximately $50,000,000 for each risk. NEPIA syndicate will provide insurance against radioactive contamination arising out of or pertaining to nuclear installations for power, experimental or testing purposes and operations or facilities related or incident thereto, with coverage specifically tailored to meet all of the property damage insurance requirements of the industry.

### NELIA

Third-party liability coverage, which, with reference to stock casualty companies will be underwritten by another syndicate group, known as NELIA (Nuclear Energy Liability Insurance Assn.), comprising 110 companies, was also organized in May, 1956.

### MAEP

Another group, the mutual fire and casualty companies (Mutual Atomic Energy Pool—MAEP) was similarly organized with an estimated capacity in excess of $15,000,000 to be available for any one installation, either for liability or physical damage coverage, or a combination of the two.

### Construction and Beyond

Where construction and installation work is being done, but no nuclear power source of any sort is present, the usual builder's risk will be available, with a provision that as soon as any nuclear fuel or fissionable material or any reactor machinery is moved on the premises, such standard, normal type of insurance ceases. For the stock companies, NEPIA will handle the builder's risk after nuclear perils have been introduced.

**Small Users**

Individual insurance companies will probably handle through their regular operations the protective requirements against normal contingencies for users of radioactive isotopes, such as research organizations and medical centers, except where unusually large quantities of radiation sources are involved. The potential effect of future exposure on the presently insured properties is now under study by various insurance groups as a new 'peril to be insured against.'

**Catastrophe**

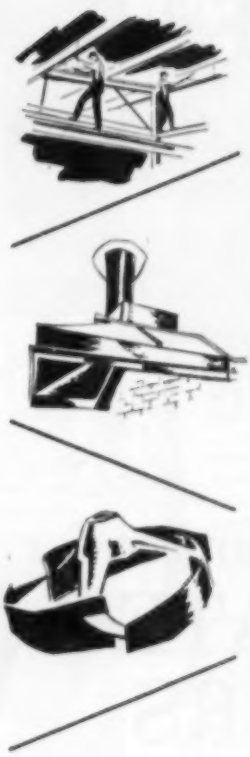
However remote, the catastrophe potential of a contamination-type of nuclear accident, because of the denial of use of machinery, equipment, buildings, and adjoining properties, has been considered more serious from an insurance loss standpoint than anything now known in industry. A single accident could cause total damages of an unprecedented aggregate that could exceed the capacity of any group of underwriters. Direct and subrogated claims plus additional claims brought against any manufacturer of component parts of the installation alleged to be defective as well as against the plant operator could result in an amount which could place in jeopardy even the biggest industrial firms. The best agreed-upon solution appeared to be for the insurance industry to provide primary protection up to a reasonable limit with the Federal Government providing for extraordinary damage by way of an indemnification protection.

A statement made public last Spring by the AEC cited a study on the environmental damage that might result under a "worst possible" runaway excursion, completely shattering or volatilizing the reactor case and its containing structure, with subsequent release of considerable radioactivity. For a 100,000 kilowatt reactor (about the size of those planned for Consolidated Edison of New York and Commonwealth-Edison of Chicago), the loss potential would probably be between $50 million and $200 million, and if the plant were to be located in an area of 250-500 persons per square mile, 20 to 50 persons could be killed and 300 to 500 exposed to possible damage levels of radiation. For a larger capacity reactor of 1,000 megawatts, the damage potential might approach and even exceed $1 billion.

**Government Aid**

At a Washington hearing last Spring, witnesses from industry, insurance companies, government, public and private

(*Continued on page 126*)

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An ATLAS Protective Coating for Every Purpose . . .

**No one coating will serve every purpose. Physical and chemical limitations require selection of the coating most effective in protecting equipment from splash and fumes of corrosive agents used in each processing operation. Atlas experience can help you take the guesswork out of coating selection.**

**Pioneers in corrosion protection, Atlas produces a complete line of neoprene, vinyl, styrene, epoxy, chlorinated rubber and polyester coatings. Atlas engineers will be pleased to recommend, from this line of protective coatings, the most economical and effective coating to combat the specific corrosion problems that exist in your plant.**

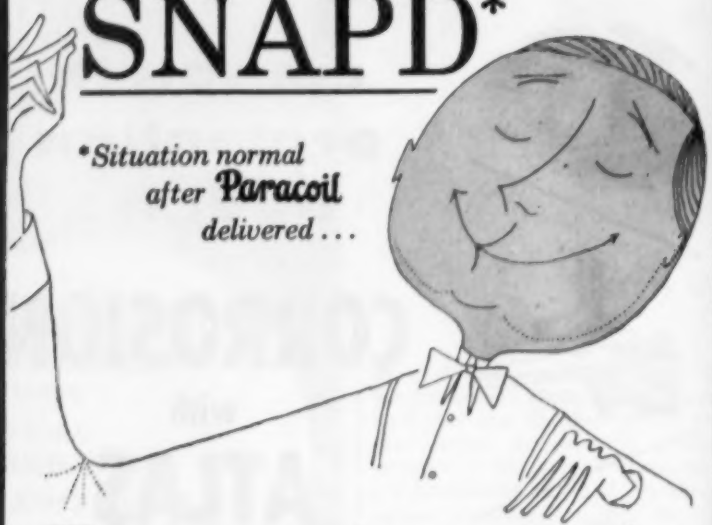
***FOR FURTHER DATA . . . Write for Bulletin 7-2***

**TECHNICAL REPRESENTATIVES LOCATED THROUGHOUT THE UNITED STATES.**

ATLAS MINERAL PRODUCTS COMPANY
MERTZTOWN, PENNSYLVANIA

# SNAPD*

*Situation normal after **Paracoil** delivered . . .



## The *new* major source for OIL & WATER COOLERS

The new Paracoil Oil and Water Coolers—Type "P" Exchangers—are solving production problems throughout industry. In addition to prompt delivery, users are finding these advantages:

- Tube bundles removable without removing connected piping. Only one set of bolts need be backed off
- Built with standard components
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- Wide selection of materials
- Standard commercial, ASME or Marine Code construction
- Close baffle tolerances for maximum heat transfer
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**Oil Coolers** – for bearing, turbine, hydraulic systems, transformer, gear oil systems.

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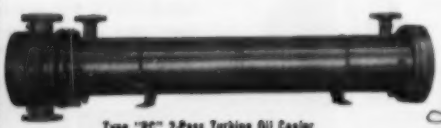
**Water Coolers** – for internal combustion engine and compressor jacket water, electrolyte solutions, brine solutions, boiler blow-down, condensate, etc.

*For stationary and marine service*



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## NUCLEAR RISKS

(*Continued from page 125*)

utility groups, and rural cooperatives reflected the general opinion that legislation was urgently needed to permit government resources to be added to that of private insurers. The Joint Congressional Committee on Atomic Energy approved and introduced into Congress a bill (S.4112) on June 21 to indemnify reactor builders, manufacturers of component parts, operators and those supplying them with material, equipment or service, whether AEC contractors or licensees, to the extent of $500 million for each facility within the U. S. and for each incident above the limit of third party liability available from private sources. The 84th Congress adjourned on July 27 without action on this bill; however, there are good prospects of early enactment in the next Congress when it reconvenes next January.

It is doubted that the lack of Congressional action will hold back atomic development and parallel risk planning for insurance, since no privately licensed power or fuel reprocessing plants are scheduled to get into actual operation before the new Congress convenes.

### Probabilities

Several important matters yet remain to be attended to before the extent and cost of insurance can be determined and premium rates set for the various operations. In view of the experimental nature of the present reactor program, no sound basis is yet available for estimating either the probabilities of nuclear accidents for risk appraisal and determination of limits, or the actual insurance needs for the various areas to be serviced.

It is expected that the technical liaison currently in process of development between the insurance interests, the nuclear industry technical personnel, and the specialized talents of the Commission itself, will promote a vigorous study of the operational perils brought about by radiation conditions. The subsequent development of criteria for materials of construction and standards of design and operational practice will do much to provide preliminary yardsticks for approximating insurance costs. Every advance in the appraisal of the hazards presented by this unprecedented technology will greatly minimize the frequency and severity of the peril of radioactive contamination, and enhance the security of nuclear power and the growing industrial irradiation program. This is an area in which chemical engineers will doubtless make many important contributions.

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*remember final control is the SPRAY NOZZLE you use!*

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## SK FLOW INDICATOR PROVIDES DUAL SCALE FOR WATER OR AIR

Now, you can obtain approximate measurement of *water flow in gpm and air flow in cfm* with SK's Fig. 18123 Ball Flow Indicator.

Note the dual scale, for water and air, on the Flow Indicator in the illustration.

This indicator uses a ball to indicate flow in a pipe line. The position of the ball, in relation to the water or air scale graduations gives approximate indication of fluid rate-of-flow.

SK Fig. 18123 Ball Flow Indicators, made of bronze, are carried in stock in ¼, ½, ¾, 1, 1½, and 2 in. pipe connection sizes. Write for prices.

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***Iolyte* TANKS**
Fabricated to your Specifications

**NO MOLDS NEEDED** — Made any size, any shape, at no extra cost and no loss of delivery time.

**UNIFORM DIMENSIONS — NO TAPERING** — Dimensions are same at bottom and top . . . means larger capacities than tapered molded tanks.

**FLANGES, DAMS, Etc.** — Can be inexpensively equipped with flanged connection, holes, overflow dams, baffles, separations, etc.

**CHEMICALLY RESISTANT THROUGHOUT** — Fabricated from *Iolyte* sheet properly reinforced. This is a structural material . . . not a lining.

*Write for literature, prices, and table of chemical resistance for Iolyte tanks, crocks, ducts.*

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|---|---|---|---|---|---|---|---|
| 5 | 9" | 18" | 18.00 | 14 | 18" | 12" | 35.00 |
| 5 | 10" | 15" | 18.00 | 20 | 18" | 18" | 40.00 |
| 5 | 12" | 16" | 22.00 | 26 | 18" | 24" | 45.00 |
| 8 | 12" | 20" | 24.00 | 30 | 18" | 28" | 49.00 |
| 10 | 12" | 24" | 26.00 | 40 | 18" | 36" | 59.00 |
| 12 | 12" | 24" | 23.00 | 50 | 18" | 48" | 69.00 |
| 9 | 10" | 24" | 21.00 | 27 | 22" | 18" | 49.00 |
| 7 | 9" | 24" | 26.00 | 30 | 22" | 20" | 53.00 |
| 10 | 16" | 12" | 28.00 | 55 | 22" | 24" | 70.00 |
| 12 | 16" | 14" | 33.00 | 73 | 22" | 36" | 83.00 |
| 15 | 16" | 18" | 40.00 | 55 | 22" | 48" | 76.00 |
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| 40 | 16" | 48" | | | | 48" | 125.00 |

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SINGLE SCALE LOGARITHMIC RADIATION SURVEY METER

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For Health-Safety monitoring to maintain radioactivity safety standards

Provides complete radiation measurement from 3.0 to 3,000 mr/hr . . . eliminates scale switching errors . . . detects x-ray, gamma and beta radiation, within ±20% at any scale point. Unique 1-tube circuit (Pat. app. for) . . . extremely long-life self-contained battery power supply with external meter-read check . . . internal constant current source for calibration . . . single control knob for simple operation.

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## ADDITIONAL A.I.Ch.E. DIRECTOR CANDIDATES NOMINATED BY PETITION

(For three-year terms beginning 1957)

**J. H. KOFFOLT**—Educator and consultant. Prof. ('40-) and chmn. ('48-) of dept. chem. engr., Ohio State U. With Amer. Steel & Wire ('23); Indust. Rayon Corp. ('24-'26); Skenandoa Rayon Corp. ('26-'28); Ohio Salt Co. ('28-'29); joined Ohio State U. in 1929. Asst. Dir. Chem. Defense, State of Ohio; consultant and indust. research supervisor for Fed. Govt., State of Ohio, and industry ('31-). Secy. of 28th Annual Meeting, co-chmn. 50th Annual Mtg. Charter mbr. and past chmn., Central Ohio Sect. Couns., Ohio State Stud. Chap. ('48-). Mbr. Local Section, Membership, & Equip. Testing Proc. (Dist.) Committees of A.I.Ch.E. ('44-'52).

**R. E. ZINN**—Educator and consultant. Prof. ('53-) of chem eng., Northwestern U.; ptnr. ('54-) and sr. chem. engr. ('51-), Vern E. Alden Co. (engineers, Chicago). Victor Chemical Works, chem. engr. ('27-'37), chief chem. engr. ('37-'44), chief engr. ('44-'51). Civilian, O.S.R.D. ('44). Northwestern U. lecturer chem. engr. ('51-'53), prof. ('53-). Formerly chmn. and dir. Chicago Section, has served on its By-Laws, Professional Licensing Committee; also A.I.Ch.E. Equipment Testing Procedures (Pumps), and Educ. and Accred. Committees.

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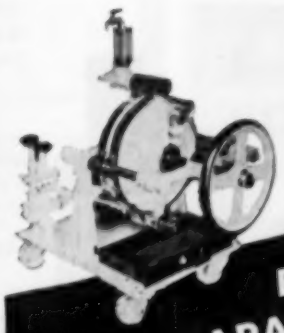
**Further details on these and other candidates (see August C.E.P.) are available from the Secretary's office. Any member who wishes this biographic data need only request it.**

**EBW Model Filter**
Equipped with 3 gpm pump and electric motor. Stainless steel or bronze nickel plated circulatory system. Holds 4 to 8, 12-1/4" dia. disks.

Ertel Portable SMALL CAPACITY FILTERS

EFS-B filter is recommended for small batches where sludge or filter aid is required. Also advantageous because no rubber washers are required . . . the asbestos sheets form their own seal. The EBW filter is ideal for high polishing filtration using filter pads.

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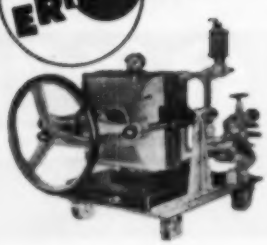

**EFS-B Model Filter**
Designed for use with any type filtering medium, 12" x 12" square. Single hand wheel provides trouble-free operation. Bronze nickel plated or stainless steel circulatory system.

**A two-week course in Industrial Statistics was held at the University of Oklahoma, July 9-20,** under the direction of R. L. Huntington, research professor of chemical engineering. Emphasis was placed on the application of statistics in the solution of refining and chemical processing problems, design of experiments, analysis of data, etc. Among those attending the course were the A.I.Ch.E. members: B. T. Brown, Phillips; George Kellen, Chemstrand; D. M. Strasser, Witco; George Cummings, Rohm & Haas; Mervin Rosenbaum; and C. C. Sprinkle, Jr., Procter & Gamble. Other companies represented were: Carbide & Carbon, Champion Paper, Continental Oil, Corning Glass, Humble Oil, Kaiser Aluminum, Lion Oil, Monsanto, Naval Powder, Pakistan Ind. Devel. Corp., Reynolds Metal, Shell Oil, and Taiwan Fertilizer. □

**The 1956 Cryogenic Engineering Conference was held September 5, 6 and 7, at Boulder, Colo.** The second meeting of its kind in this important new field, the conference was devoted to engineering problems in the low-temperature range, that is, below 150° K. (—190° F.). Among the low-temperature engineering topics covered were: bubble chambers, instrumentation, properties of materials, insulation, and cryogenic equipment and processes.

The field of cryogenic engineering is growing rapidly as the use of liquified gases by industry and national defense units increases. Unusual engineering problems are encountered in the design and construction of safe, large and more efficient equipment for producing these gases because of the marked differences in the behavior of materials at very low temperatures. □

**The National Industrial Conference Board's Atomic Energy Course for Management will be held Oct. 1-5** at the Biltmore Hotel in New York. The course is a nontechnical course designed for business executives who are not scientifically trained. Attendance is limited to 200 and registrations will be accepted in order of receipt. □

**Chemicals and Non-Metallics Day at the National Industrial Exposition in Detroit will be October 26.** A management-engineering conference by a panel of manufacturing experts will cover new ideas in the field of chemicals and their importance in plastics, rubber, wood, paper, and textile industries. Wednesday's session, October 24, will take up the electronic and atomic fields. □

Lawrence Vertical Top-Suction Liquid Oxygen Pump

PUMPS to handle LIQUID OXYGEN

At —297.4° F. — the boiling point of liquid oxygen — many abnormal factors must be considered in designing a centrifugal pump. Metals become brittle . . . packing will freeze solid . . . the net positive suction head is usually very low, so that the liquid is at or near its boiling point. All of these difficulties are successfully overcome in Lawrence Vertical Top-Suction liquid oxygen pumps.

Lawrence construction employs metals not affected by the extreme low temperature and locates the packing far enough above the liquid so that it is exposed only to the oxygen vapors and functions normally. Location of the suction on top prevents vapor binding, even at boiling point.

If your problem involves pumping a liquefied gas at extreme low temperature, write us the pertinent details. No obligation.

Write for Bulletin 203-7 for summary of acid and chemical pump data.

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Multi-Wash units are flexible, too. They can be constructed of any of several corrosion resistant alloys, or have their interior surfaces covered with special coatings. Also, plain carbon steel can be used in many cases by recirculating an alkaline solution, resulting in large savings to the user.

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# EJC NUCLEAR CONGRESS AND A.I.Ch.E. ATOMIC EXPOSITION AT PHILADELPHIA IN 1957

**National Industrial Conference Board joins the 19-society group for Congress and Exposition to be held March 11-15, 1957.**

Second and undoubtedly most comprehensive EJC Nuclear Engineering and Science Congress, accompanied by A.I.Ch.E.'s Atomic Exposition, is now scheduled for March 11-15, 1957, in Philadelphia's Convention Hall.

Of paramount interest to chemical engineers will be a symposium on "the fuel cycle" sponsored by the Nuclear Engineering Division of A.I.Ch.E.

Major added feature: National Industrial Conference Board's 5th Atomic Energy for Industry Conference. Specially rescheduled to run in conjunction with the Congress and Exposition, the NICB meeting covers atomic energy and the nuclear industry from the management angle.

Walter G. Whitman (left) and Bruce R. Prentice head expanded EJC Nuclear Congress.

"The Congress and Exposition," according to Walter G. Whitman, general chairman of the Congress, "is a prime example of how progress in the civilian use of atomic energy is being immeasurably expedited through such cooperative action." Whitman, current president of A.I.Ch.E., was secretary-general of the U.N.'s Geneva Atomic Conference.

**Program**

Program chairman of the conference is B. R. Prentice of General Electric. One hundred and thirty technical papers are expected, dealing with all phases of nuclear operations from the mining of ores to the disposal of radioactive wastes. Emphasis will be placed on new developments of potential value to civilian industry.

A.I.Ch.E.'s part of the program will consist of six sessions on the fuel cycle: 1—Uranium and thorium production (F. L. Cuthebert and F. Culler); 2—Fuel cycle interrelationships (E. B. Gunyou and J. C. Robinson); 3—Fuel manufacture (F. Foote and R. B. Briggs); 4—Spent fuel reprocessing-aqueous (R. B. Richards); 5—Spent fuel processing-non aqueous (S. Lawroski); and 6—Economics (M. Levenson and J. Hogerton).

**Exposition Expands**

The 1957 edition of A.I.Ch.E.'s International Atomic Exposition, sponsored this year in cooperation with the four other major engineering societies, expects to have over 200 exhibitors displaying the latest equipment for harnessing atomic power and for other nuclear applications. Attendance is expected to exceed the 18,991 figure registered at the highly successful 1956 Exposition in Cleveland. "Our basic problem," Whitman said, "is how to expedite the dissemination of information on new developments. Expositions like this . . . can talk to more potential users of atomic energy in a shorter time."

Another major bonus at Philadelphia will be the 5th Hot Laboratories and Equipment Conference which will deal with the construction and management of laboratories for atomic research.

---

**The first international conference dealing with ozone will be held in Chicago, November 28-30.** Sponsored by Armour Research Foundation of Illinois Institute of Technology, the conference is expected to attract leading scientists from throughout the world. Armour Research has long been an expert in the ozone field. □

**A graduate program in the design, selection and operation of computers will be inaugurated this fall at Stevens Inst. of Tech.** It is the first such program to be made available to full-time industry employees, classes will be held two nights a week for three years. Far more extensive than previous short courses, the Stevens course will lead to a Master of Science degree, will enable graduates to design and build computers for special requirements as well as make selections among standard models. Graduates will also be able to fully program the machines. □

**A Conference on Computer Applications will be held in Chicago, October 9-10,** under the sponsorship of Armour Research Foundation.

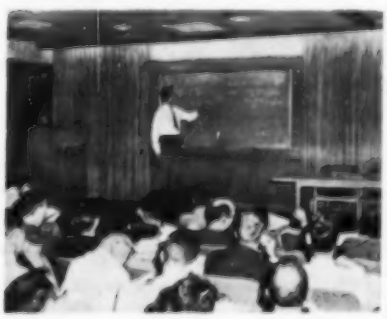
The Foundation will also sponsor the National Conference on Industrial Hydraulics, October 18-19, also in Chicago. □

## INSTITUTIONAL NEWS

**The Eleventh Midwest Quality Control Conference will be held October 11-12 in Minneapolis, Minn.** There will be 15 technical sessions and an elementary training course. Among the many subjects covered by the speakers will be the latest progress that Statistical Quality Control has made in the fields of engineering, inspection, cost reduction, research and other related areas. A "Statistical Smorgasbord" will highlight the final session where the panel of professors will answer individual questions pertaining to quality control. Wives of attendees are invited, fee will be $20 for the two days, information can be had from Robert Keane, P.O. Box 4337, Minneapolis, 18. □

**Five educational institutions are participating in a newly established agency for research on military problems.** Called the Institute for Defense Analysis, the new agency is a non-profit corporation established to conduct scientific analyses of present and future weapons systems for the Weapons Systems Evaluation Group of the Dept. of Defense. The five schools are: M.I.T., Cal. Tech., Case, Stanford and Tulane. Heading the new agency are J. R. Killian, president of M.I.T., and Maj. Gen. J. McCormack, Jr., U.S.A.F. (Ret.). □

**Sales of exhibit space are running ahead of expectations for the 1956 Trade Fair of the Atomic Industry** to be held on the Navy Pier in Chicago, September 24-28. Sponsors of the Fair, Atomic Industrial Forum, also sponsor the concurrent annual conference on "management and technology in the atomic industry." □



**At the recently-held "industry sponsored school" on Numerical Analysis and the Use of Computing Machines, J. Douglas, Jr., lectures to a group of 24 engineering professors and 48 members of the staff of Humble Oil, the sponsoring company. Douglas' subject, the numerical integration of partial differential equations, was one of two main topics covered at the important session held in Houston's Research Center. The second main topic covered was a study of computing machines and their uses.** □

**W & T CHLORINATION...**

*complete algae control for 25% of the cost of best previous treatment*

**The Geo. Wiedemann Brewing Co., of Newport, Kentucky had an algae problem on the water-side surfaces of their pasteurizers that increased operational costs, cut pasteurization efficiency, caused corrosive pitting of the units, and created very objectionable odors.**

**Five years ago, after trying other treatments, a Wallace & Tiernan chlorinator and proportioning solution panel were installed. The chlorination treatment has been completely successful in eliminating the problem at about one-fourth the cost of the best treatment tried previously.**

**A Wallace & Tiernan chlorination system can correct problems caused by algae growths in your process. Write for our free bulletin 2136-C that describes the Geo. Wiedemann Brewing Co. case history, and tell us of your specific problem.**

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**SEBACIC ACID**

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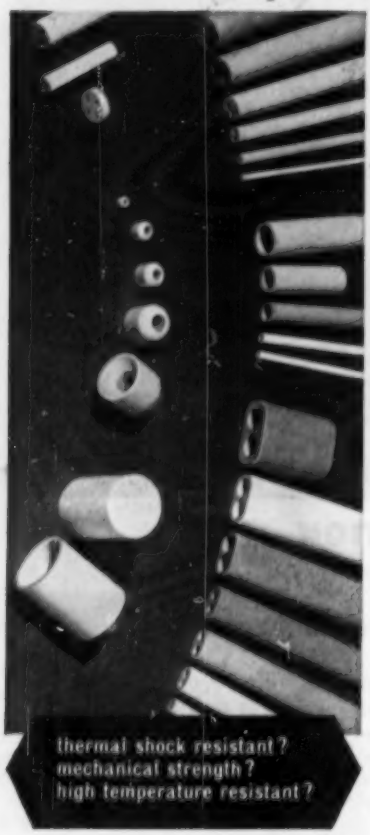
# Insulators for Thermocouples

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# FUTURE MEETINGS and Symposia of the Institute

**MEETINGS** **SYMPOSIA**

■ **ANNUAL—BOSTON, MASS.**
Dec. 9-12, 1956. Hotel Statler.

*In Boston: Paul Revere, Old North Church.*

TECHNICAL PROGRAM CHAIRMAN: W. C. Rousseau, Badger Mfg. Co.

**Filtration**

CHAIRMAN: F. M. Tiller, U. of Houston.
The flow of liquids through compressible media with experimental and theoretical papers.

**Low Temperature Techniques**

CHAIRMAN: Clyde McKinley, Air Products Inc.
Papers dealing with gas prepurification for low-temperature processing and the low temperature aspects of heat exchange, refrigeration, distillation and liquid-vapor equilibria, and the properties of materials.

**The Sales Engineer in Chemical Engineering**

CHAIRMEN: W. E. Hesler, Swenson Evaporator Co., E. D. Kane, Cuno Eng. Corp.
Three Panels: "Introducing Mr. Chemical Sales Engineer," "Training the Chemical Sales Engineer," "Performance Yardstick of the Chemical Sales Engineer."

**Laboratory Facilities for Nuclear Engineering Education**

CHAIRMAN: Joseph J. Martin, U. of Mich.
Presentation of costs and uses of nuclear equipment in various educational curricula.

**Chemical Engineering in the Pulp and Paper Industry**

CHAIRMAN: E. C. Bowen, The Bowen Corp.
Co-chairman: L. C. Jenness, Univ. of Maine. Session of technical papers followed by discussion panel of industrial leaders.

**Advancing the Automatic Control of Chemical Process Plants**

CHAIRMAN: Wayne Alexander, Monsanto Chem. Co. Co-chairman: David M. Boyd, Univ. Oil Products. A C.E.P.-sponsored "session-in-the-round" evolving company practices and defining process design and personnel training needs.

**Owning Your Own Business**

Sunday afternoon panel discussion.

■ **WHITE SULPHUR SPRINGS, W. VA.**
March 3-6, 1957. Greenbrier Hotel.
TECHNICAL PROGRAM CHAIRMAN: S. G. Friedman, E. I. duPont de Nemours & Co., Benger Lab., Waynesboro, Va.

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**Computers in Chemical Company Control**

CHAIRMAN: W. M. Carlson, du Pont, Engineering Service Div., Newark, Delaware.

The use of large-scale computers in handling payrolls, billing and ordering, sales forecasting, production control, etc.

**Futures in the Chemical Industry**

CHAIRMAN: R. E. Chaddock, Hercules Powder Co., Virginia Cellulose Dept., Wilmington 99, Del. Co-chairman: Geo. Rieger, Diamond Alkali Co., Cleveland Ohio.

■ **PHILADELPHIA, PA.**

March 10 through 16, 1957.

EJC Second Nuclear Engineering and Science Congress & Exposition. See news story on page 130.

■ **SEATTLE, WASH.**

June 9-12, 1957. Olympic Hotel.

**Industry's Role in University Programs on Nuclear Engineering**

CHAIRMAN: John Kaufmann, Div. of Reactor Development, U. S. Atomic Energy Commission, Wash., D. C.

**Chemical Engineering Data and Calculation Methods**

CHAIRMAN: W. C. Edmister, Calif. Research Corp., Richmond Laboratory, Richmond, Cal.

■ **BALTIMORE, MD.**

September 15-18, 1957. Lord Baltimore Hotel.

■ **ANNUAL—CHICAGO, ILL.**

December 8-11, 1957. Conrad Hilton Hotel.

TECHNICAL PROGRAM CHAIRMAN: Henry F. Nolting, Standard Oil Co., 2400 New York Ave., Whiting, Ind.

**Fluidization of Solids**

CHAIRMAN: E. R. Gilliland, Chem. Eng. Dept., M.I.T., 77 Massachusetts Ave., Cambridge 39, Mass.

Flow characteristics, rate of entrainment and heat transfer; fluidized reactors vs. fixed and moving bed reactors.

**Effective Cost Control in Process Operations**

CHAIRMAN: C. W. Nofsinger, The C. W. Nofsinger Co., 906 Grand Ave., Kansas City 6, Mo.

**Evaluation of Projects from the Original Idea to the Investment Stage**

CHAIRMAN: C. W. Nofsinger (see above).

**Chemical Engineering Abroad**

CHAIRMAN: Shelby Miller, Chem. Eng. Dept., Univ. of Kansas, Lawrence, Kansas.

**Corrosion Resistant Alloy Materials of Construction**

CHAIRMAN: G. Fred Ours, Carbide and Carbon, Charleston, W. Va.

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■ **ST. LOUIS**

June 3-7, 1957.

Golden Jubilee Meeting, Air Pollution Control Association; sponsoring societies include A.I.Ch.E. (Tuesday, June 4 will be A.I.Ch.E. day.)

Papers are solicited on the following subjects: Methods of Analysis; Instrumentation; Atmospheric Reactions, Photochemical & Other; Aerosol Formation & Control; Progress in Air Pollution Control Equipment & Methods; and Human & Economic Goals for Engineers in Air Pollution Control.

*(Continued on page 137)*


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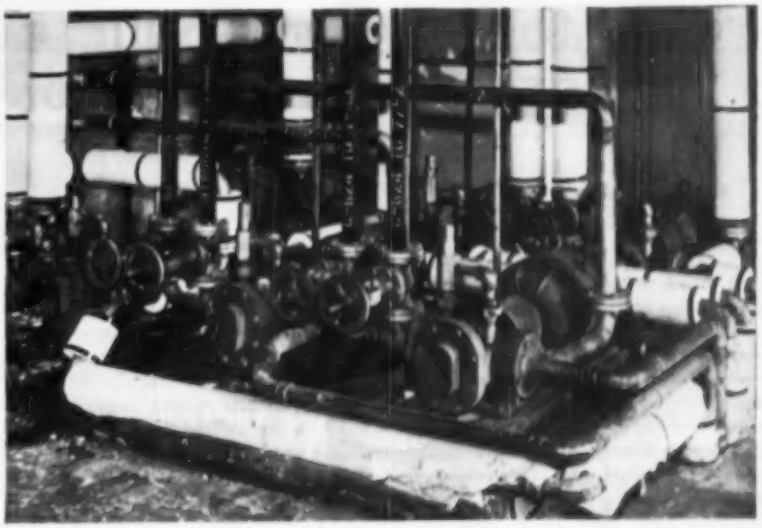
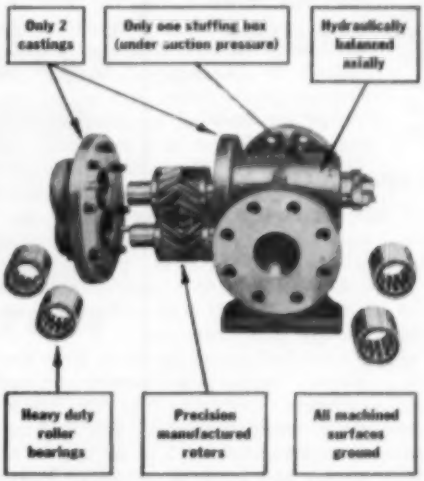
Shown below are six Hydrex Pumps at the General Electric Company, Schenectady, N. Y., used for unloading tank cars and transfer pumping of Diallyl Phthalate, Melamine, Soya Fatty Acid and Formalin. Model 2½ C-5 Hydrex Pumps shown have type 2A Ni-Resist body, bearings and packing glands. Shafts are of Type 316 stainless steel.



***Sier-Bath* HYDREX PUMP**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**With the AEC now permitting access * to thermonuclear information and the Russians having revealed recently the results of certain of their experiments, many chemical engineers are expected to be ready for a briefing on "what fusion is all about." To provide an up-to-date summary, *CEP* received assistance from Brookhaven's D. J. Hughes, who kindly prepared the following interpretation and commentary on the Russian revelations. These, incidentally, point up how a major mechanical obstacle was circumvented, for the purpose of their experiments, through the use of a radically different approach.**

# CONTROLLED THERMONUCLEAR REACTIONS PROGRESS TOWARD "FUSION" POWER

*D. J. Hughes* | Brookhaven National Laboratory, Patchogue, N. Y.

Last April, before a group of English scientists at Harwell, Russian Academician Igor Kurchatov revealed many details of the Soviet position in the thermonuclear field. Because of the unprecedented nature of the information revealed, a summary of the more salient points covered may serve to give *CEP's* readers an awareness of some of the problems faced in general and how the Russians have gone about them on a "test tube" basis, circumventing (for the time being) one of the main engineering obstacles: the achievement of particle excitations (temperatures) sufficient to surmount with appreciable probability the forces of repellence between particles, without having to design a container to withstand impossibly tremendous pressures.

### Containment of Gaseous "Plasma"

"Fusion" energy is given off when light nuclei, such as those of hydrogen, deuterium, or tritium, are combined to form heavier nuclei, such as those of helium. Kurchatov began his talk by describing the fundamental problem of attaining power from thermonuclear reaction—the containment of a gaseous "plasma" (atoms in a sufficient state of thermal excitation to be almost completely ionized) at the temperature required. This temperature is in the order of several million degrees. At such temperatures no ordinary methods of containment are practical and resort must be made to electromagnetic fields for keeping the ionized gas from escaping. It is of course possible to accelerate a limited number of ions, as is commonly done in the cyclotron, but the amount of matter speeded up in this way is much too small. For practical results, the entire mass of material must be raised to the high temperature rather than a small fraction of it. Nuclear reactions would begin to take place in the ionized plasma and energy would be evolved.

### "Pulsed" Discharges

However, such a static arrangement, as was pointed out by Kurchatov, is inherently unstable and the Russians turned early in their program to the interesting concept of using, instead, "pulsed" or momentary discharges. The electromagnetic forces in a pulsed discharge are such as to cause the discharge to contract to a very fine line. This "pinch effect" was thought capable of causing a rapid rise in temperature in the condensed discharge column, possibly to high enough levels. Soviet scientists studied these "pinched" gaseous discharges in a number of gases, using moderately high voltage but extremely heavy currents.

Electrical energy stored in large condenser banks was passed through cylinders containing the gas under study, usually deuterium. The discharge tubes ranged from 5 to 60 cm. in diameter and up to 2 meters in length. The current pulses passed through these tubes ranged up to two million amperes, and instantaneous power rates were as high as forty million kilowatts. In the discharge the inductive resistance is very important; thus the voltage rises as the discharge shrinks to a line in the pinch effect because of the concentration of current. The voltage then suddenly drops as the concentrated discharge breaks into an irregular shape because of its instability. After the break of the pinch, rather complicated voltage-current relations develop because the currents and field in the tube then attain complicated shapes; at times severe currents actually develop.

The test of the attainment of high temperatures sufficient for "fusion" in the momentary pinch is the evidence noted of an appreciable number of nuclear reactions in the form of high-energy x-rays and neutrons emerging from the pinch. These radiations, particularly the neutrons, indicated quite definitely that nuclear reactions were taking place in the gaseous discharge. According to Kurchatov, as early as 1952 Soviet scientists found such evidence. It was at first thought that they had reached the temperatures (of the order of a million degrees) necessary to produce nuclear reactions. However, extensive tests showed that the temperature could not have been that high at the currents used in the experiments. Rather, the velocities of excitation resulted from local high electric fields that somehow were a result of the extreme instability of the pinch as it collapsed. These high electric fields could accelerate deuterons to a sufficient energy that they could make nuclear reactions, primarily the well-known reaction involving the combining of two nuclei of deuterium:

$$d + d \rightarrow He^3 + \text{neutron}$$

in which neutrons of about 2 million electron volts * of energy are emitted.

(*Continued on page* 136)

* See article on Access Permits, page 88.

* A radio tube having a potential difference between its plate and cathode of 200 volts is said to excite its electrons to an energy level of 200 electron volts.

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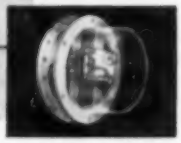

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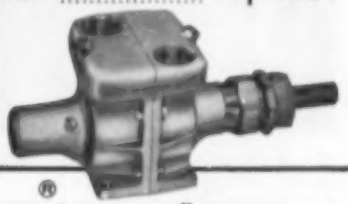

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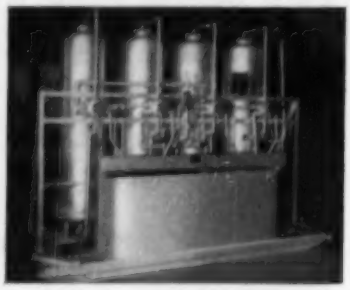

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## THERMONUCLEAR REACTOR

(*Continued from page* 134)

These neutrons are not, however, produced by a true thermonuclear effect, for they result from the ordered motion of only a small fraction of the ions in the discharge tube. Thus, while the Soviet scientists no doubt produced nuclear reactions in their discharge tubes, they did not produce the conditions under which all of the material would be heated to a sufficiently high temperature that nuclear reactions could be sustained to a point approximating the emission of energy comparable to that introduced into the system.

### "True" High Temperature

In order to make a power-producing thermonuclear reaction, it will be necessary to reach a true high temperature, that is, to have all the ions in the gas moving at high speed, in *disordered* motion. The *ordered* motion produced by the local momentary high electric fields in the Soviet experiments is not a true temperature. Another fundamental difficulty of the pulsed discharge approach is that the nuclear reactions are produced for only a very short period of time and thus the duty cycle of the operation would be quite low. However, it would seem very difficult to produce a more steady state type of discharge at a very high temperature because of the inherent instability of a pinched plasma. That true "fusion" temperatures could result from the pulsed discharge has met with enough difficulty that as yet no true temperatures in the thermonuclear region have been attained.

### Advantage of "Fusion" Power

One of the decided assets to be enjoyed when power by "fusion" is attained in practice, is the absence of highly radioactive fission products such as are produced in the case of a normal chain (fission) reaction. The very penetrating high energy neutrons that are produced by fusion will however, not be without resultant problems. Extremely thick shielding will be required. In addition, the radiation damage effects of these high energy neutrons on the materials of the thermonuclear reactor itself will be serious indeed.

It is clear that the Soviet efforts so far are devoted to the production on a laboratory scale of the extremely high temperature necessary to produce nuclear reactions. They are not yet, judging from Kurchatov's statements, at the stage where the later practical problems of production of economic power from fusing nuclei have been faced.

## FUTURE MEETINGS

**MEETINGS** **SYMPOSIA**

(*Continued from page 133*)

At least one author must be a member of A.I.Ch.E. Title and abstract of 100-150 words should be sent to Chairman Lauren B. Hitchcock at Air Pollution Foundation, 704 S. Spring St., Los Angeles 14, Cal. Deadline November 1, 1956.

### LOCAL SECTION MEETINGS

■ **NEW YORK**

October 18, 1956. Hotel Statler.

1-day meeting. Morning: Advances in Food & Pharmaceutical Industry. Afternoon: Petroleum in the Jet Age. Also all-day panel discussion on Cost Estimation.

■ **SOUTH TEXAS**

October 26, 1956. Galvez Hotel, Galveston.

1-day meeting. Panel discussion, "Trends in Plastics and Synthetic Rubber"; general session; Symposium, "Energy Sources of the Future"; student session, general; and small group discussions (limited to 25 people), "The Problem of Unionism" and "Plant Operating 'Bugs'."

CHAIRMAN: C. L. Fitzgerald, Maintenance Engineering Corp., Houston, Texas.

■ **CHICAGO**

November 7, 1956. Conrad Hilton Hotel.

1-day meeting. Morning: The Pros and Cons of Unionism for Engineers. Afternoon: What Management Expects of the Engineer.

Gen. Arrangements chairman: Hal M. Hart, Standard Oil Company, P. O. Box 431, Whiting, Indiana.

■ **SOUTHERN CALIFORNIA**

October 16, 1956. Rio Hondo Golf Club, 10627 Old River School Road, Downey, Calif.

H. R. Emmerson, Union Oil Co., "Sulfur and Its Removal from Petroleum."

### AUTHOR INFORMATION

#### Submitting Papers

Procedure to be followed is, in brief:

1—Obtain four copies of "Proposal to present a paper before the A.I.Ch.E.," plus one copy of "Guide to Authors" from Secretary, A.I.Ch.E., 25 West 45th St., New York 36, N. Y.

2—Send one copy of completed form to Technical Program Chairman for meeting selected from above list.

3—Send another copy to Mr. E. R. Smoley, The Lummus Co., 385 Madison Ave., New York 17, N. Y. (Asst. Program Comm. chairman).

4—Send third copy to Editor, Chemical Engineering Progress, 25 West 45th St., New York 36, N. Y. Paper will automatically be considered for possible publication in A.I.Ch.E. Journal.

5—If desired to present paper in a selected symposium, send fourth copy to chairman of the symposium.

6—Prepare five copies of manuscript. Send one copy each to Symposium chairman, Technical Program chairman, or both copies to former if no symposium is involved. Other three copies should be sent to Editor, C.E.P. Presentation at meeting offers no guarantee of acceptance for publication.


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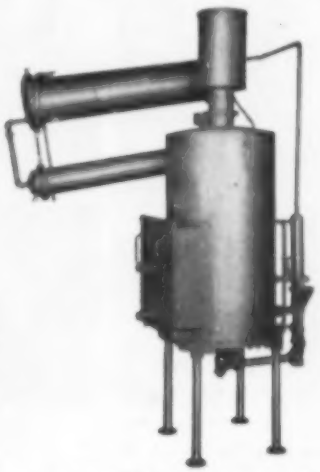

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Boston, they say, is a state of mind completely surrounded by water. It is also the "Cradle of American Liberty." Now it is to be distinguished again by being for the fourth time since 1913 (a very recent date in Boston history) host to an Institute meeting. Boston, in short, is the site of A.I.Ch.E.'s next National Meeting, December 9-12, 1956.

History and culture. These are the best known attributes of Boston. In fact, so much is said regarding these that Boston is less well known as a friendly, compact host city that has nearly every and any facility sought by a visiting engineer.

Perhaps still less known, even by chemical engineers, is the fact that Boston is the "cradle of chemical engineering." It was here that Arthur Little developed the whole idea of the unit operations concept, and it was here, in 1888, that MIT offered the first full curriculum in chemical engineering in the world.

That is history, chemical engineering history, but symbolic of Boston's dynamic character is that today MIT is at the center of one of the main reasons no chemical engineer should miss the Boston meeting—"Trillion Dollar Row." Here, in the Boston suburb of Cambridge, is concentrated some of the world's greatest diversification of scientific minds. MIT alone has more than 70 special laboratories used for teaching as well as for research. Boston is the home of education and research. Here are Arthur D. Little, Godfrey L. Cabot, National Research Corp., and many other research institutions. Here are, in addition to MIT and Harvard, Boston University, Boston College, Northeastern University, Tufts College, and for the ladies, Wellesley and Radcliffe. No chemical engineer should want for an opportunity, while attending the meeting, to visit as many of these great institutions as his interest and timetable may permit.

### The "Feel" of History

Boston is a warm, compact city of red brick buildings, small, narrow streets lined with quaint little buildings, squares and small parks like the world-famous Boston Common. It is a unique city, the only truly old city in the nation, and, like London, you have to *feel* it, feel the sense of time, of history, and of the austere endurance that has made our country great.

No city in the world, with the exception of London, is more suited to walking. And no city, except London, has more history per square foot.

*Freedom Trail*, clearly marked by pointers, starts at the gilded dome of the great statehouse on Beacon Hill (built by Boston's answer to London's Christopher Wren—the architect Bulfinch, who has left more mark on Boston than any other man). From the statehouse follow the signs to Boston Common, built now over the subway and unique as is all of Boston in that the graves disturbed to build the subway were all carefully replaced. After the Common you will pass Granary Burial Ground with the graves of John Hancock, Sam Adams, Paul Revere, and "Mother" Goose. Then comes Old South Meeting House where the Tea Party was planned, and the Old State House where the Convention met to adopt the Federal Constitution, the scene of the Boston Massacre, Faneuil Hall, called the actual "cradle of liberty," the Paul Revere House, oldest in Boston, and Old North Church, its famous steeple rebuilt, where the lanterns signaled the approach of the British to Paul Revere. Copps Hill Burial Ground marks the end of *Freedom Trail*, but *Old Ironsides* is on view at the Navy Yard across the Charlestown Bridge.

And this is just a sample of the historical sites Boston has to offer, and just in Boston itself. Even in its easternmost position geographically, the city is the center of the widest area of living history in the country. To see this, even if you don't have your car, rent one, and go to Concord, Lexington, the Wayside Inn, perhaps Salem or Gloucester or Plymouth.

### Art and Music

There was a time when the only culture in America centered in Boston. These were the days of Emerson, Whittier, Longfellow, Hawthorne, Melville, Thoreau, and a host of other great names. Today the city still is a center of the best in cultural activities.

There is the world-famous Boston Symphony, which will be playing during the meeting. There are the museums of art: Museum of Fine Arts, Fogg Art Museum, Isabella Stewart

Ewing Galloway
View of Harvard University across the Charles River from Boston.

Gardner Museum, Guild of Boston Artists, and the Institute of Contemporary Art. Boston is a city of churches, and the site of the Mother Church of Christ, Scientist, which was founded here.

**The Gourmet**

If it is food, real dining and not just eating, you want, Boston is the home of New England cooking, of chowder, *real* clam chowder, of baked cod, of lobster, and, of course, baked beans as beans should be baked. But it is also a cosmopolitan city, has been since the first New England captain sailed to China and back, and you will find just about any type of cuisine you want within a short distance of the hotel. There is Durgin Park, Locke-Ober Company, Lobster House, Parker House, Town House, Union Oyster House, Vendome Hotel, Sheraton-Plaza, or Jacob Worth.

**The Magic Semi-Circle**

The Hub of Commerce and Industry is a just title for this city which produces products annually valued at over two billion dollars. Boston's new circumferential highway, the "Magic Semi-Circle," forming an 80-mile loop around the city, has brought an industrial boom to Greater Boston. In the past five years, more than 110 new industrial plants worth approximately $150 million have been established on or near this route. The recent announcement of Metal Hydrides, Inc.'s new $5 million metallurgical products plant at Danvers, Massachusetts, is one indication of new developments in the chemical industry.

Esso Standard Oil Company's refinery at Everett, Massachusetts, serves all New England with a complete line of primary petroleum products.

The Everett Plant of Eastern Gas and Fuel Associates is a basic business in

(*Continued on page* 145)

"Varec" AUTOMATIC TANK GAUGES

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FIG. NO.
2500C

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6. Built to API Standard 2500 for custody transfer.

FIG. NO.
2500RC

"Varec" Fig. No. 2500C is designed for gauging liquid level of chemicals stored in high pressure spherical tanks. Gauge head has heavy carbon steel flange to permit bolting for high pressure service.

"Varec" Fig. No. 2500CR is an inverted design of the Fig. 2500C, permitting its use on all tanks, below or above ground, where top readings are required. Stainless steel tape connects from gauge head to float in a straight line, eliminating use of sheaves and brackets, thus reducing friction and promoting greater accuracy.

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# WKNL IN THE NEWS

**NUCLEAR AIRCRAFT**

Walter Kidde Nuclear Laboratories has been selected by the Glenn L. Martin Company to begin engineering for extensive test facilities related to the Navy Nuclear Powered Aircraft Program.

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**NUCLEAR POWER PLANT**

Corps of Engineers, Research and Development Laboratories, Fort Belvoir, Virginia, has selected WKNL to design a one-cycle emergency nuclear power plant. Design is expected to be completed in approximately seven months.

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**NUCLEAR-MINDED**

Among WKNL's clients are a number of the nation's leading corporations, including Curtiss-Wright Corporation, Convair Division of General Dynamics Corporation, Continental Oil Company, Westinghouse Electric Corporation, Baldwin-Lima-Hamilton Corporation and others. A growing trend is that more and more companies are making their own privately-financed investigations into various applications of nuclear technology to their own products and processes.

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A.I.Ch.E. **News of the Field** FROM LOCAL SECTIONS

## CHEMICAL ENGINEERING—JOB OR PROFESSION?

**Major panel-session of Northern California Section in June discussed this vital subject, heard results of poll on same subject.**

"Is chemical engineering a job or a profession?" A panel of four local engineers of recognized standing in the field led the **Northern California Section** in the discussion of this major contemporary problem. Panelists were: T. Vermeulen, professor of chemical engineering, Univ. of Calif.; W. W. Davison, Standard Oil of California; F. W. Meyer, Bechtel Corp.; W. J. O'Connell, consultant, Burlingame, Calif.; and moderator W. C. Edmister, California Research Corp.

The engineers also heard the results of a professional opinion poll conducted two months prior to the meeting.

The subject implies two alternatives that needed defining. *Job*, application of technical skills to the problem of the employer without associating own interests with those of management. *Profession*, applying technical skills to advance interests of employer (and self) by rendering a "thinking" engineering service.

**Results**

Major points brought out by the poll and the discussion were:

- Most chemical engineers associate their interests with those of management. Collective bargaining is inconsistent with the professional interests of chemical engineers.
- Most chemical engineers prefer managerial to technical work at the same salary. (This is apparently due to ambition to advance and the lesser prestige and opportunity in technical work.)
- Relationships between management and engineering staff would be improved if supervisors attended and took part in meetings of professional societies, thus setting an example to working level engineers.
- Professional recognition, both inside and outside company circles, is important to chemical engineers but is not handled adequately by employers.
- Most chemical engineers do not think their pay is commensurate with their value to industry. (Their main complaint is that they don't know where they stand or what to look forward to.)
- Chemical engineers are concerned about the shortage of high school math and science teachers and are interested in teaching methods.
- Chemical engineering is an honorable profession for those who recognize that their interests and those of management are similar while maintaining personal integrity. Technical and professional progress depend on employers and employees recognizing and encouraging individual achievements.

Northern California Panel: l. to r., Vermeulen, Davison, Edmister, Meyer, and O'Connell.

**Distinct Field of Knowledge**

Professor Vermeulen pointed out in his remarks that the chemical engineering profession is differentiated by having a distinct field of knowledge as its basis, and also by providing the key engineering services in one major economic area.

Davison emphasized that industry must aid the chemical engineer to develop professionally by encouraging attendance and participation in local professional society meetings, and by sending men to national gatherings. Industry can also foster professional development by keeping its engineers in close contact with academic circles.

Teamwork is an essence of true professional engineering, Meyer pointed out, and a man who leads a project today may be following tomorrow.

One point of disagreement came when O'Connell disagreed with the opinion poll and felt that the chemical and engineering salesmen make important technical contributions in solving operating and design problems in customers' plants and should be considered qualified for membership in A.I.Ch.E.

*—W. C. Edmister*

## NEW SECTION AT SYRACUSE

Last May slightly more than one half of the chemical engineers located in Central New York met at Syracuse University to organize a local section. To date a set of by-laws has been drawn, acted upon, and adopted. Several committees have been nominated which operated during the summer months to advertise the newly formed organiza-

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tion and thus assure success during the first year.

Close association with the Cornell group of engineers is planned. The section has been planning its first year's program all summer and is highly optimistic over the possibilities for high activity during the first year.

Officers of the new section are: Chmn., H. P. Munger, Syracuse U.; vice-chmn., R. A. Hiserodt, Solvay; secretary, A. E. Skrzec, Bristol Laboratories; treas., J. F. Keville, Carrier Corp.; exec. comm., R. K. Finn, Cornell U., C. S. Grove, Jr., Syracuse U., and C. P. Hackett, Solvay.

*—A. E. Skrzec*

**Members of New York Section on June plant trip to Chas. Pfizer in Brooklyn. Tour began with a talk on fermentation as a chemical engineering process, and then the group saw the laboratories, chemical engineering pilot plant area, production facilities for ascorbic acid, and pharmaceutical packaging operations.**

**New Officers**

New officers of local sections for 1956-57 are: **Detroit Section:** chmn., D. W. Anderson; vice-chmn., J. D. Leslie; secretary, R. D. Stevenson; treas., N. Nix; directors-at-large, T. J. Oleszko, R. Laitner. **Kansas City Section:** chmn., J. R. Salsbury; chmn-elect, F. Fowler; secretary, D. Jones; treas., J. R. Brown; exec. comm., T. L. Gore, L. S. DeAtley, S. M. Walas. **Washington-Oregon Section:** chmn., R. E. Florine; vice-chmn., G. C. Szego; sec.-treas., J. Heitman; councilor no. 1, J. L. McCarthy; councilor no. 2, R. E. Noble. **Rhode Island Section:** chmn., A. A. Melnychuk; vice-chmn., A. R. Thompson; sec.-treas., J. L. Campanella; directors, W. W. Farnum and F. Votta, Jr. **Alton-Wood River Section:** chmn., A. C. Hershey; vice-chmn.-membership, C. J. Barr; vice-chmn.-program, A. E. Ruscilli; secretary, W. L. Maag; treas., L. L. Gurley. **New Jersey Section:** chmn., D. M. MacLaren; chmn.-elect, J. Axelson; recording-sec., A. B. Welty, Jr.; corresponding-sec., R. W. Davis; treas., D. M. Calkins; exec. comm., J. D. Stett, R. H. Wilhelm and E. M. Powers. **Charleston (W. Va.) Section:** chmn., J. K. Harvey; vice-chmn., R. V. Green; sec-

*(Continued on page 142)*

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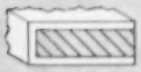
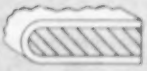
## 4 Basic Designs

1 **Slit-center.** Teflon is slit from outside diameter to within 1/16" to 1/4" of the inside diameter. Any type filler can be used.



2 **Milled-center.** Machined from outside diameter. Provides flat surface flush with pipe I.D. reduces impedance to flow.



3 **Formed Shield.** For large or irregular openings such as elliptical manholes.

4 **Double Jacket.** Two jackets overlapping to protect both O.D. and I.D. Filler of compressed asbestos between layers of soft woven asbestos commonly used.

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## News of the Field

### FROM LOCAL SECTIONS

(*Continued from page* 141)

retary, J. R. McLain; treas., D. D. Hulett; member-at-large, W. L. J. Aschenbrenner. **Rochester Section:** chmn., W. Eilinger; vice-chmn., R. Kraybill; secretary, R. Boutros; treas., J. McMillen; directors, S. Miller, J. Oldshue, and E. Mohr. **Midland Section:** chmn., C. D. DeBord; vice-chmn., J. Eichorn; secretary, T. Bishop; treas., D. Burdick; exec. comm. members, J. Ashley, R. Greenhalgh.

### THERMODYNAMICS, TITANIUM, AMONG LOCAL SECTION SUBJECTS

The historical development of the Generalized Methods of Thermodynamics was the subject of O. A. Hougen, Carborundum Corp., in his talk before the May meeting of the **Twin Cities Section** (*E. J. Murray*). The most important parameter introduced into the Generalized Methods, according to Hougen, was the "compressibility factor at the critical point." This parameter, with the critical temperature and pressure, enables the engineer to calculate the vapor pressure, fugacity and other properties.

Hougen recommended the Generalized Methods in lieu of known data, but emphasized that it is not suitable for precise values or for vapor pressure at low temperatures.

#### Titanium and Some Trends

The development of titanium metal for process applications in other than cost-is-no-object situations is one of the fast moving fields of today. H. Kessler, Titanium Metals Corp., pointed this out to the May meeting of the **Southern California Section** (*F. G. Sawyer*), and went on to say that the possible applications of titanium for corrosion resis-

tance in competitive chemical and petroleum industries is of direct concern to the chemical engineer.

Trends and predictions in the chemical industry were the order of the day at the May meeting of the **Pittsburgh Section** (*M. M. Ramer*). A. R. Powell, former research director of Koppers, compared the actual statistics for 1955 production of certain chemicals with predictions he made in 1950 for the President's Report, and went on to make further predictions for 1975. Some of his figures were:

| | '55(pred.) | '55 | '75(pred.) |
|---|---|---|---|
| | (million lb.) | | |
| Naphthalene consumption | 347 | 700 | 566 | 1700 |
| Ethylene consumption | 1500 | 3000 | 2600 | 8000 |
| Phenol production | 312 | 600 | 489 | 1500 |
| Styrene production | 539 | 1000 | 1011 | 3000 |
| Ammonia (syn.) (thousand tons) | 1520 | 2880 | 3152 | 5600 |

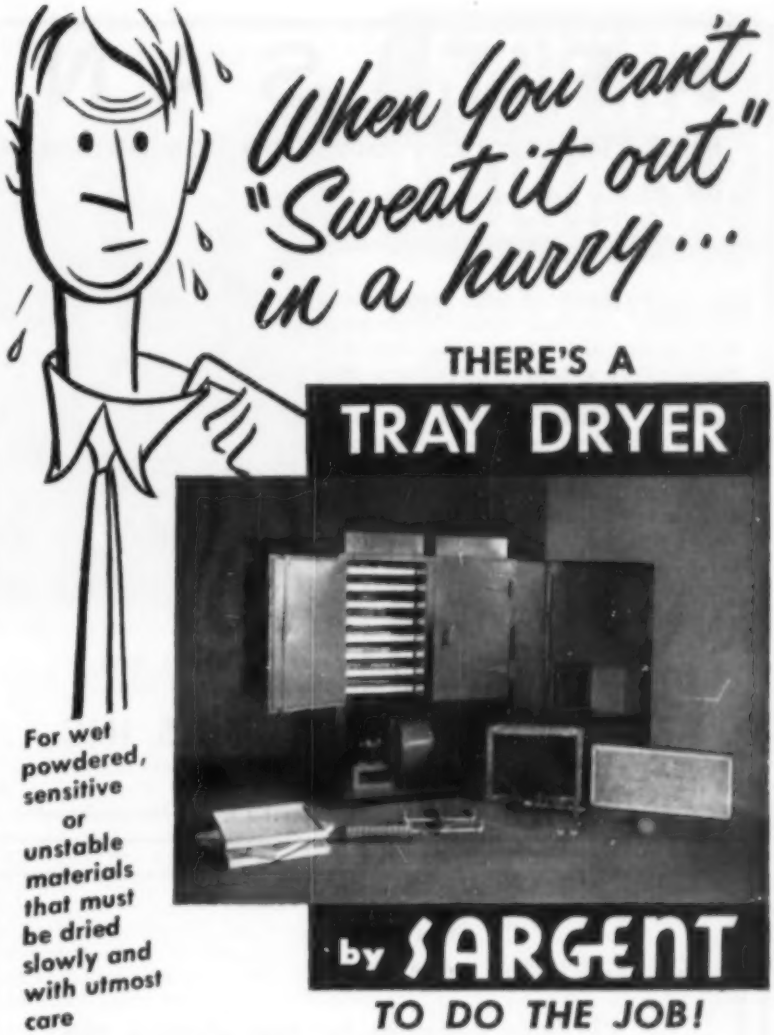
**Ejectors**

There are two types of ejectors depending on performance, C. G. Blatchley of Schutte and Koerting Co. told the May meeting of the **East Tennessee Section** (*R. F. Hunt, Jr.*). The first type is non-critical, usually has liquid as the motive fluid, and can be controlled merely by throttling the motive fluid. The second type is critical, has gas (usually steam) as the motive fluid, and cannot be controlled by throttling the motive fluid because it operates at essentially fixed flow. With this type the common control method is to supplement the process fluid with another fluid. Multistage ejectors operate in the same manner, except that where condensables are present the supplementary fluid must also be condensable. Usually steam is bled in, but the exhaust product may also be recirculated. Where the load is mostly condensable, the ejector may be controlled by throttling on the condenser water flow to maintain constant tail pipe temperature. Ratio control can also be used on this type of system.

**Fluid Mixing Technology**

Quantitative definition of process performance in a mixing operation is one of the keys to effective mixer design, stressed J. Y. Oldshue, Mixing Equipment Co. Speaking to the **Central Pennsylvania Section** (*P. A. Barrett*), Oldshue illustrated how recent research work has been directed toward establishing quantitative process definitions for mixing operations such as heat transfer, gas-liquid contacting, solids

(*Continued on page* 144)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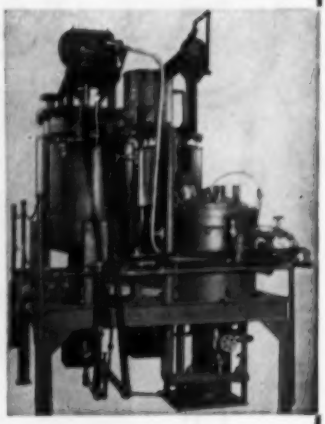

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## News of the Field

### FROM LOCAL SECTIONS

(*Continued from page* 143)

suspension, and others. With these quantitative definitions, the effect of mixing variables can be predicted and correlated, and comparisons between various operating conditions can be made.

#### Urea Plant

The new ammonia and urea plant of the Grand River Chemical Division, Deere & Co., at Pryor, Okla., was the scene of the plant trip that formed the June meeting of the **Tulsa Section** (*G. L. Farrar*). The plant features extensive use of automatic control, compact layout, reduced equipment size, and a relatively high degree of process integration. Designed by Foster Wheeler, the plant has a daily capacity of 180 tons of ammonia and 260 tons of urea. The Casale high pressure process is used for ammonia and the Pechiney process for urea.

#### Do Engineers Become Obsolete?

F. M. Tiller, dean of engineering, Univ. of Houston, believes that engineers can become obsolete. Talking to the June meeting of the **South Texas Section** (*G. B. Gibbs*), Tiller pointed to the tendency to specialize in narrow fields, the tendency not to continue education after college. In this respect, Tiller emphasized his belief that education and the continuance of education should be phased.

#### Silicones and Taxes

Intensified research in the field of industrial use of silicones has led to many novel applications, Gordon McIntyre, Dow-Corning, told the June meeting of the **Tidewater Virginia Section** (*B. S. Halsey*). Increased usage of silicones can be expected in the fields of electrical wiring, plastics, textiles and lubricants.

The **Idaho Section** (*W. L. Chase*) has been conducting a campaign to convince its representatives in the Congress that the income tax law should be changed to remove the inconsistencies in application of the provision that says moving expenses, when paid in cash to the engineer moving, can be taxed as income. The section feels that this money is not actually given with any freedom to spend it, but rather is simply the company paying a necessary expense of its operation. In practice most companies do pay this themselves instead of giving the money to the employee to pay.

**THE ATOM AT WORK**

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## BOSTON MEETING

(*Continued from page 139*)

Ewing Galloway

**Paul Revere lived in this, the oldest house in Boston, until 1800. It is now a museum.**

New England's economy. The coke plant, producing coke, gas and chemicals, and the blast furnace producing pig iron, are its two major units. The gas formed in the coking process is sold to the Boston Gas Company.

Industrial chemicals and chemical specialties for the paper, leather and metal working industries are produced at Monsanto Chemical Company's multi-million-dollar plant in Everett. Service by ocean-going vessels is one of its unique features.

Dewey and Almy Chemical Company, a division of W. R. Grace and Company, is located in Cambridge.

Many engineering and manufacturing firms specializing in the design, fabrication, and operation of chemical process units and complete plants have their facilities in the Boston area. Representatives such as Artisan Metal Products, Inc., Stone and Webster Engineering Corp., and Badger Manufacturing Corp. allow local chemical producers to draw on Boston industry for the solution to almost any problem that may arise.

### Conclusion

According to the 1950 census there are 1067 chemical engineers in Massachusetts, and there will be a lot more on December 9-12. Be prepared to walk, if you want to see Boston, but if you don't, there are restaurants for every taste, the tryouts of most Broadway plays come here and you can see the shows *before* the critics do, and there is sure to be one of the best technical meetings to date.


MOVING LIQUIDS?

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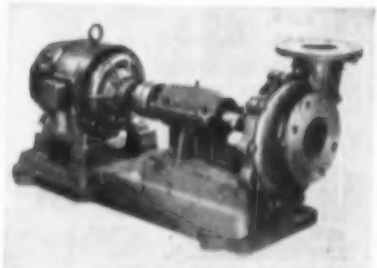

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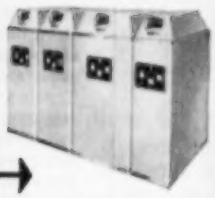

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# people

**Bernard Sullivan,** senior project engineer, is assigned by American Viscose—Film Division to the Fredericksburg, Virginia, engineering department where he will assist in coordination of activities.

**Elwood E. Martin** joins Monsanto Chemical, St. Louis, as a member of the engineering staff. He was previously with Mobay Chemical, St. Louis.

With the beginning of the fall semester **William H. Kapfer** is advanced from the rank of assistant professor to associate professor in the chemical engineering department of New York U.

**Horace E. Luntz** is appointed technical assistant to the manager of development and research at Continental Oil Co., Ponca City, Oklahoma. He has served in various positions in the development and research department since joining the firm in 1936.

**Eugene P. Whitlow** joins Southwest Research Institute's department of chemistry and chemical engineering, San Antonio, Texas, from Servel, where he has been for the past 12 years. Dr. Whitlow is a refrigeration and air conditioning expert and holder of patents on absorption refrigeration.

**James H. Klein,** former research associate and instructor at M.I.T., has joined the guided missile research division of the Ramo-Wooldridge Corp., Los Angeles.

**John C. Garrels, Jr.,** of Monsanto's plastics division in Springfield, Mass., is appointed assistant general manager in charge of marketing, research, manufacturing, engineering and personnel relations.

**Tidewater Local Section president George Dean, center above, congratulates John C. Howard (right) and Philip C. Halladay, Jr. (left), as they receive the section's scholastic awards as the outstanding chemical engineering graduates in the Virginia Tidewater area. Howard (Univ. of Virginia) and Halladay (Virginia Polytech) were awarded one year memberships in A.I.Ch.E.**

*(Continued on page 153)*

# CLASSIFIED SECTION

Address Replies to Box Number Care of CHEMICAL ENGINEERING PROGRESS

## SITUATIONS OPEN

**Realize the Maximum Out of Your Degree and Experience By Associating with——** *Linde* **in**

**ACETYLENE ENGINEERING AND DEVELOPMENT**

The expanding acetylene program at our new, air conditioned Speedway Laboratories located in suburban Indianapolis offers unusual and challenging career openings. Our needs are for CHEMICAL ENGINEERS interested in and capable of assuming responsibility for new projects in the following fields:

- **DEVELOPMENT** of novel methods of acetylene production and distribution
- **DESIGN** of new plants for supplying chemical acetylene in pipeline quantities
- **ENGINEERING** for our production plants and distribution systems
- **TECHNICAL SERVICE** for Linde's nationwide acetylene business

These activities offer challenge to engineers interested in:

- **heat transfer**
- **fluid flow**
- **catalysis**
- **gas kinetics**
- **thermodynamics**
- **pressure vessel design**

B.S., M.S., or Ph.D. graduates submit résumé covering education (approximate academic achievement), experience and work interests.

**LINDE AIR PRODUCTS COMPANY**
**A division of**
**Union Carbide and Carbon Corporation**

Att.: Mr. J. J. Rostosky P. O. Box 8237, Indianapolis 24, Indiana Refer to ad: CEP-A

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Offers immediate long range opportunities for

## ENGINEERS
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Process or project experience in refinery, petrochemical or chemical fields.

Liberal relocation allowances for you and your family.

Send Résumé to
Manager of Employment & Placement
Industrial Relations Division

*For an immediate personal interview you may phone:*

Paul Keating, Plaza 7-4400, New York City
Joe Braddick, Fairfax 3-2401, Houston, Texas
Bill Milligan, Tucker 1549, Los Angeles, Calif.
Don Palmer, Douglas 2-4032, San Francisco, Calif.

## BECHTEL CORPORATION

220 BUSH STREET San Francisco 4, Calif.

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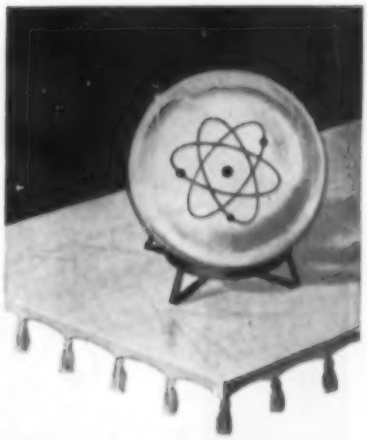


# YOUR FUTURE in ATOMIC POWER

Atomic power, we feel, offers outstanding opportunity for an engineer or scientist to grow professionally. It's new enough so that the work is challenging; still it's well enough established so that a capable man can make real progress.

If you are interested in a non-routine position that will use all of your education and experience, we suggest you investigate the future with the leader in Atomic Power. At Bettis Plant, there are select positions open for specially qualified:

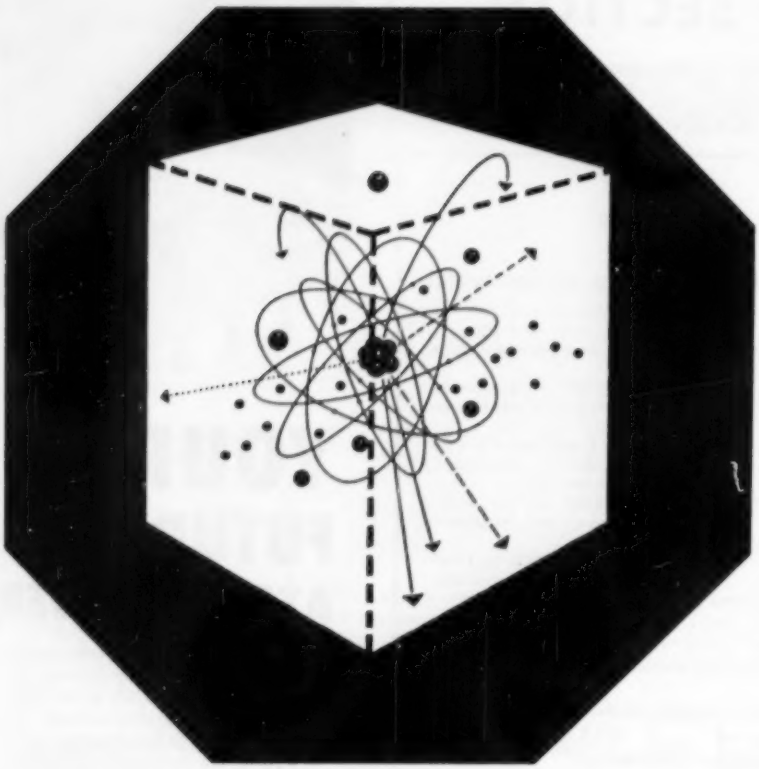
- **PHYSICISTS**
- **MATHEMATICIANS**
- **METALLURGISTS**
- **ENGINEERS**

Write for the booklet "Tomorrow's Opportunity TODAY" that describes opportunities in your field. Be sure to indicate your specific interests.

Write: Mr. A. M. Johnston
Dept. A-57
Westinghouse Bettis Plant
P. O. Box 1468
Pittsburgh 30, Penna.

## BETTIS PLANT
## Westinghouse

*FIRST IN ATOMIC POWER*



# power in the small economy size

Harnessing the atom with the development of transportable nuclear power is probably the greatest of all impending events.

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Already forseeable is a reactor capable of delivering 2,000 kw for a year and a half from a single fuel bundle occupying less than 8 cubic feet of space.

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*This immense field of research and development offers one of the great engineering opportunities in the world today. If you are interested, contact J. M. Hollyday, Dept. CEP-09, The Martin Company, Baltimore 3, Maryland.*

**MARTIN**

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Interested in High Temperature Reactions? An exceptional opportunity for chemists, physicists or engineers to work in a new laboratory devoted to an intensive study of high temperature reactions for development of new thermally and chemically stable compounds for industry.

The men we want should have a working knowledge of thermodynamics, physical chemistry and heat flow or an interest in the design and construction of special thermal reaction chambers.

Emphasis will be placed on solid state or gaseous reactions occurring above 1500°C and evaluation of materials formed under these conditions.

If you are interested in helping to develop this rapidly growing new field and would like to work in a modern, well equipped laboratory for a leader in high temperature technology, please call or write to:

**Mr. R. M. Bushong**
**Director, Development Laboratory**
**National Carbon Company**
**A Division of Union Carbide and Carbon Corporation**
**Fostoria, Ohio**

## CHEMICAL ENGINEERS WANTED

One of the fastest-growing companies in the chemical industry, manufacturing heavy and fine chemicals, and plastics, requires engineers for process engineering. Work consists of plant, pilot plant and laboratory work in connection with process improvement, efficiency, quality, and equipment evaluation studies of existing plant processes. One to four years' experience desirable but not necessary. Opportunity to obtain broad experience in technical problems of diversified chemical manufacture. Salary commensurate with experience. Apply Industrial Relations Dept.

**Hooker Electrochemical Co.**
**Niagara Falls, New York**

## SALES ENGINEER

**AIR SEPARATION PLANTS**

Graduate engineer familiar with air separation technology and with ten years of experience in sales of process plants or related fields.

Excellent opportunity with leading firm of engineers and constructors in New York City.

Submit in confidence complete chronological resume, including education and salary history.

**Box 2-9**

## CHEMICAL ENGINEERS

### Foreign Employment

For career assignments in technical service and research and development work in a large modern refinery installation in Saudi Arabia. Excellent opportunities for diversified experience and advancement assured by complexity of present installation and future expansion.

Liberal salary plus allowances and all-inclusive benefits. Opportunity to travel on long vacations and live in modern community with complete facilities including extensive recreation.

Write giving full particulars regarding personal history and work experience.

Please include telephone number.

Recruiting Supervisor, Box 175

**ARABIAN AMERICAN OIL COMPANY**

505 Park Avenue

New York 22, New York

## CHEMICAL ENGINEERS

Interesting opportunities exist in central research and development laboratory for men with B.S. or higher degree in chemical engineering. One to eight years' experience desired, preferably in research and development in inorganic field or extractive metallurgy. Attractive opportunities to work on challenging problems in our expanding laboratory.

Please send detailed resume including educational background, work experience and salary desired to:

Mr. A. A. Marquer, Jr.
CRUCIBLE STEEL CO. OF AMERICA
P. O. Box 88 Pittsburgh 30, Pa.

## CHEMICAL ENGINEER

For industrial research and development department in large fertilizer company in the Mid-West. M.A. degree in chemical engineering preferred. Experienced in process development or plant operations. Should possess administrative ability to work with design engineers and operating personnel. Excellent opportunity. Give age, experience, salary range. Write Box 1-9.

## PLANNING ENGINEER

### CHEMICAL—METALLURGICAL

**JOB:** broad company-wide planning with nationally known non-ferrous metals firm.

**EXPERIENCE REQUIRED:** extractive metallurgy and/or heavy chemicals. Economic evaluation.

Salary open. Send complete résumé —age, training, experience, salary desired. Box 3-9.

# 5...4...3...2...1...?

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Rock-anchored into the crags of the Santa Susana Mountains near Los Angeles crouch the massive test-stands of ROCKETDYNE – the most gigantic rocket engine workshop in the Western Hemisphere. The privileged men who tend these great power plants are a select group indeed. For no matter what their specialty, they are working at the most advanced state of their art.

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Day by day the tests go on, and every day produces its two miles of information on oscillograph tape – fascinatingly new information, far in advance of available texts. This is one of the newer industries with an assured future. The methods now being developed here for producing effective power to the attainable limits of mechanical stress will have wide application. Such experience is practically unobtainable anywhere else.

The only way you can appreciate the far-reaching significance of such a program is to be a part of it. Will you accept the challenge?

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**FOR ENGINEERING GRADUATES:** Aeronautical, Chemical, Structural, Electrical, Electronic, Metallurgical, Mechanical; qualified for Analytical, Research, Development or Design responsibility.

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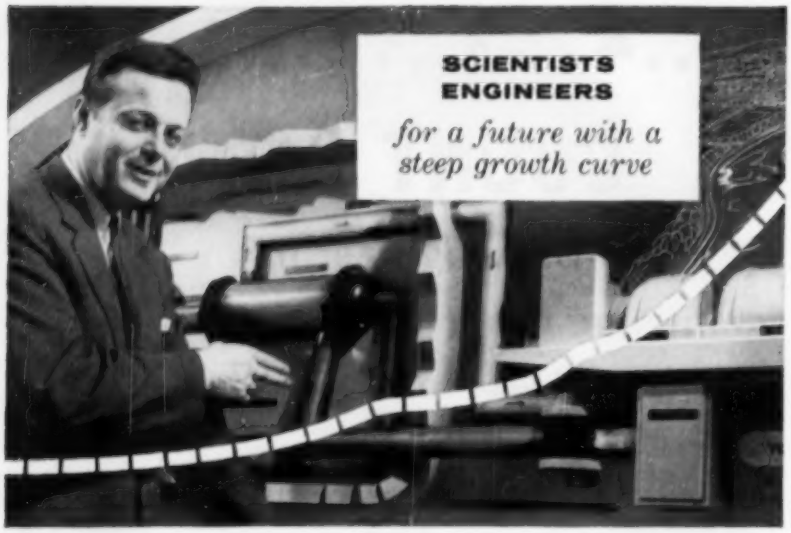
**INTERESTING BOOKLET.** Facts about rocket engines and engineering. Send for your personal copy of "The Big Challenge." Write: A. W. Jamieson, Rocketdyne Engineering Personnel Dept. **9CEG,** 6633 Canoga Avenue, Canoga Park, Calif.

**ROCKETDYNE**

A DIVISION OF NORTH AMERICAN AVIATION, INC.

BUILDERS OF POWER FOR OUTER SPACE

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CAPA—Commercial Atomic Power Activity—is the nucleus of the most dynamic new division at Westinghouse, the leader in Atomic Power. Our growth is bound to be *steep*—as electric power demand and atomic power production pyramid sharply.

We're "fluid"—not fixed. New supervisory jobs open up fast! We're entirely *commercial*—not dependent on government contracts. Opportunities for advanced study at company expense. Get in on the "industry of tomorrow" *today* . . . at Westinghouse CAPA.

**Immediate Openings** for professionally established men and those just starting their careers: Physicists • Physical Chemists • Chemical Engineers • Mechanical Engineers • Electrical Engineers • Designers • Metallurgists.

*Send your résumé*

Please mail résumé of your professional and business background to: C. S. Southard, Westinghouse Commercial Atomic Power, Box 355, Dept. 186, Pittsburgh 30, Pennsylvania.

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### NUCLEAR ENGINEER

Our Engineering and Construction Division at Pittsburgh has a position open for Nuclear Engineer. Requires chemical engineering or related degree with five to ten years' experience, including substantial design experience in nuclear energy fields; must have Q clearance; unusual opportunity for work on important engineering assignments. Write giving details of experience and salary requirements to:

**J. S. Magee**
**Personnel Department**
**KOPPERS COMPANY**
**Pittsburgh, Pennsylvania**

### OPERATING ENGINEER

**NEW YORK OFFICE**

To assist in supervising office & field and domestic & foreign activities of the Operating Department.

Challenging opportunity for graduate chemical or mechanical engineer with minimum five years petroleum refining experience, preferably with contracting engineering firm.

Please airmail confidential verifiable chronological resume, including salary history, to

**Personnel Department**
**HYDROCARBON RESEARCH, INC.**
**115 Broadway New York 6, N. Y.**

### PROCESS ENGINEER

An opening exists in the Chemical Process Engineering group in our Chemical Division. Chemical Engineering work will involve basic unit operations and unit process work in suspension and emulsion P.V.C. polymerization. This position offers excellent opportunities for qualified applicant. P.V.C. experience not necessary. Prefer individual with one to four years' experience. Send résumé of experience and training to:

**Mr. D. F. Martine**
**Manager Industrial Relations, Chem. Div.**
**The General Tire & Rubber Company**
**Akron, Ohio**

PROJECT ENGINEER—progressive organic chemical manufacturer requires a chemical or mechanical engineer with 4-8 years' experience. Position includes responsibility for engineering projects from inception through design and construction. Please forward complete résumé, recent photograph and salary requirements to R. N. Parsons, The Carwin Company, North Haven, Connecticut.

**Attractive fellowship available. M.S. About one year. Write:**
**Hugh D. Sims**
**Dept. of Chemical Engineering**
**Bucknell University**
**Lewisburg, Pennsylvania**

### RESEARCH CHEMIST

**UNUSUAL OPPORTUNITY IN NEW SOUTHERN LABORATORY OF**

expanding aluminum producer. Require man over thirty. Experienced in inorganic physical chemistry or chemical engineering research fused salt or electrochemical experience helpful. Position involves assisting section leader to plan and conduct research and development on primary aluminum processes. Give age, education, experience, and salary required in confidential letter to Box 14-9.

**AIR SANITATION DIRECTOR**—$624-$750. Challenging new position to formulate and implement effective air pollution control program for Contra Costa County, California. Apply Contra Costa County Civil Service Commission, Box 710, Martinez, California.

**REACTOR ENGINEERS AND SCIENTISTS ARE NEEDED**

- With 0-5 years of experience, and
- who are interested in helping to build a new company

Please write for further details

**INTERNUCLEAR COMPANY**
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# CHEMICAL ENGINEERS

**FOR PROCESS ENGINEERING**

Expansion of technical development activities in synthetic fibre division, offers the following opportunities to qualified men looking for broader responsibilities and growth.

**Chemical Engineers BS, MS, PhD**

**GRADUATE ENGINEERS** with 5 to 15 years diversified experience in process development, production or process engineering on a supervisory level. The duties involve supervising development engineers and pilot plant operators in fibre development projects including process design and process improvement.

**GRADUATE ENGINEERS** with up to 10 years experience in process development, production or process engineering. Duties will involve working with supervisory staff on development problems including pilot plant operation.

*These are permanent positions in Celanese's newly created development laboratory in Charlotte, North Carolina providing year-round attractive living and working conditions. Salary commensurate with education and experience. Please write giving full particulars on age, education, experience and salary requirements to L. H. Hitchens. All replies held in strict confidence.*

**Celanese** CORP. OF AMERICA
P.O. Box 1414, Charlotte, North Carolina

# CHEMICAL ENGINEERS

Major Oil Company has openings for Chemical Engineers in several phases of process engineering. Locations near New Orleans and south Arkansas. Attractive salary and benefits program.

In reply give age, education, experience and salary expected.

**PAN AM SOUTHERN CORPORATION**
P. O. Box 2,
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## ENGINEERING WITH . . . . Linde

- DISTILLATION
- HEAT TRANSFER
- PILOT PLANT DESIGN AND OPERATION
- PROCESS ENGINEERING
- THERMODYNAMICS
- FLUID FLOW

We have excellent openings for **CHEMICAL ENGINEERS** in projects associated with the production and distribution of oxygen, nitrogen and argon as low temperature liquids or gases.

**LOCATION:** Our Tonawanda Laboratories in suburban Buffalo, New York—our largest research and development facilities.

B.S., M.S., Ph.D. graduates—send resume covering education (approximate academic achievement), experience and work interests to:

**LINDE AIR PRODUCTS COMPANY**
a division of **UNION CARBIDE AND CARBON CORPORATION** • Tonawanda, New York • Attention: Mr. P. I. Emch • P. O. Box 44, Refer to ad: CEP-L

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C.E.P. Classified Section is the answer to the age-old question of where to get the best in chemical engineers.

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THE NEW JERSEY ZINC COMPANY (OF PA.)
RESEARCH DEPARTMENT
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- INORGANIC CHEMISTS
- PHYSICAL CHEMISTS
- PROCESS METALLURGISTS
- PHYSICAL METALLURGISTS

Research and development program on processing of raw materials, manufacture and applications of zinc, titanium, metals and alloys, pigments and new products.

Advanced degrees or research experience desirable for Research; not required for Development. We have openings for men without experience or with up to five or ten years' experience.

These openings are for permanent staff positions in a well-established research organization. Excellent laboratories and working conditions. Ideal location in Eastern Pennsylvania.

ENGINEER OR CHEMIST

# CERAMICS

**Develop High Temperature Materials for Nuclear Flight**

General Electric is now vitally committed in the area of nuclear powered aircraft. Even though General Electric has an unexcelled complex of test facilities, equipment and scientific personnel, much remains to be done. This qualified senior engineer will find our small congenial project-group just the right medium in which he can make a lasting contribution to the development of improved materials. For in truth, professional achievement is best fostered in an atmosphere of face to face stimulation. This, as much as anything else, is what you get at GE.

At least 8 to 10 years experience is required, involving non-metallic inorganic materials for use at high temperatures. (If directly related, time spent in obtaining an advanced degree may be considered part of this experience.) Applicant must be a graduate physical chemist, metallurgical engineer, or ceramic engineer, preferably with Ph.D. or equivalent.

Publication of research results in the appropriate classified or open literature is encouraged.

**OPENINGS IN CINCINNATI, OHIO AND IDAHO FALLS, IDAHO**

*Address replies stating salary requirements, to location you prefer:*

**J. R. ROSSELOT**
P. O. Box 132
Cincinnati, O.

**L. A. MUNTHER**
P. O. Box 535
Idaho Falls, Idaho

**GENERAL ELECTRIC**

*Chemical Engineers*

**PROCESS DEVELOPMENT • PROCESS DESIGN**

**How many of these advantages do you enjoy now?**

1. Opportunity to gain broad experience in process development or design ranging from engineering research to initial plant start-up on highly diversified organic chemical processes.
2. Satisfaction in exercising responsibility commensurate with your ability and experience.
3. Recognition of ability and performance by a predominantly technical management.
4. Working for a nationally known company that is financially sound, alive to the importance of research and engineering, and certain to continue its past rate of expansion.
5. Living in attractive suburban Philadelphia, close to the rich cultural atmosphere of this historic city and in the heart of the Delaware Valley, one of the nation's most rapidly growing industrial areas.

If you have a B.S. or M.S. degree with up to 5 years' experience; if you are impatient for a chance to get ahead with a company that's big enough to give you working room, but not so big that you are lost in the crowd: write, giving complete details of training and experience, including reason for considering a change of employment and the type of work desired, at:

**Office of Technical Employment**
**ROHM & HAAS COMPANY**
**5000 Richmond Street**
**Philadelphia 37, Pennsylvania**

**All inquiries will be acknowledged and held in confidence.**

## SITUATIONS WANTED

### A.I.Ch.E. Members

**CHEMICAL ENGINEER**—39, wide experience chemicals, petro-chemicals. Intensive training program, evaluation and design project engineering, initial operation, and process improvement. Accustomed high level responsibility; supervisory activity. Minimum salary $10,000. Box 5-9.

**CHEMICAL ENGINEER**—Age 25. Experience in chemical production supervision and staff engineering. Army electronics experience. Prefer challenging production position in New York area. Present salary $5050. Veteran. Box 6-9.

**CHEMICAL ENGINEER**—Age 25. M.Sc., B.Ch.E., Veteran, Married. One year pilot plant operation. Desires position utilizing full technical capabilities in research or development, with progressive company offering good opportunity for advancement. Box 7-9.

**CHEMICAL ENGINEER**—Age 48, B.E., Eighteen years' as plant or general manager of equipment. Capable of developing and managing organizations for top-notch production and distribution, research and development. Organic and inorganic experience. Box 8-9.

**CHEMICAL ENGINEER**—Seventeen years' experience in heat transfer sales and engineering; six years' experience in oil refinery operation and laboratory work. Seek responsible position with growing organization. Box 9-9.

**TECHNICAL ADMINISTRATOR**—Desire to sacrifice a fine motel which he owns to someone who can offer him a top level job. Grand location and climate in the Blue Ridge Mountains. Box 10-9.

**PROJECT ENGINEER**—Executive Assistant, M.S. Bus. Adm., B.S. chemical engineering. Age 39 with twelve years' technical and managerial experience in petroleum industry and five years' in atomic energy programs with complete project responsibilities. Foreign duty considered. Box 11-9.

**CHEMICAL ENGINEER**—Ph.D. Ten years' responsible experience process development, development-production-liaison, and plant start-ups. Publications and honoraries. Desire responsible position with definite opportunity for advancement to administrative or management level. Metropolitan New York area. Box 12-9.

**M.Ch.E.**—31, married, veteran, highest scholastic honors. Eight years' responsible experience in process development, project engineering, manufacturing, economic evaluation, quality control. Management position in development or manufacturing preferred, with opportunity for professional advancement. Northern or Eastern location. Box 13-9.

**EXPERIENCED ENGINEER**—B.Ch.E., M.S., Honors, age 32, married veteran. Eight years' petroleum processing experience large refinery. Desire position with greater management potential. Present salary $9,000. Box 15-9.

**SALES MANAGEMENT**—Ten years' successful sales engineering and instrument application to the chemical industry. Other experience five years' production supervision of petrochemicals. Desire sales management work for company vending equipment to chemical, nuclear, or metallurgical industries. Box 16-9.

## SITUATION OPEN

**CHEMICAL ENGINEER, B.S.**

4 to 8 years experience process engineering design and general plant maintenance, for New Brunswick, N. J. plant. Salary $6,000-8,000. Box No. 4-9.

# people

(*Continued from page* 146)

**J. Edward Vivian** becomes a full professor in the department of chemical engineering at M.I.T. In the same department, **Alan S. Michaels** is promoted to the rank of associate professor and **Gordon L. Brownell** to the rank of assistant professor.

**W. H. Walters** recently appointed to the development group at Linde Air Products' Tonawanda, N. Y. Labs. and **Karl G. Davis** is assigned to the molecular sieves group as an application and development engineer.

At Humble Oil & Refining's Baytown Texas refinery, **F. M. Orr** becomes technical specialist in the technical service division, **J. G. Lillard** becomes senior chemical engineer in the research and development division, and **Clinton W. Bates** assumes duties as supervising engineer in the engineering division.

**Zelvin Levine,** a nuclear engineer, is now located in Lynchburg, Virginia, with the atomic energy division of Babcock and Wilcox.

**L. Tom Ung** becomes group head in charge of the computer research group of Esso Research and Engineering, Linden, N. J. **Lawrence B. McManus, Theodore M. Rosenblatt** and **Don. E. Blaser** are new members of the economics, process research and design divisions, respectively.

Walter Kidde Nuclear Laboratories, N. Y., appoints **Frederick A. Zenz** senior engineer. He was formerly a development engineer with M. W. Kellogg, N. Y.

**George Burnet, Jr.,** is made associate professor in the chemical engineering department of Iowa State College. He is also employed half time as a group leader with the Ames Laboratory for Atomic Research.

**Arthur G. Walsh** has joined the research division staff of National Research Corp., Cambridge, Mass., and will serve as director of the process engineering department. He was formerly with American Cyanamid as assistant engineering manager, industrial chemicals division.

**Leonard A. Wasselle,** formerly with the home office of Rust Engineering in Pittsburgh, becomes manager of the Boston office.

(*Continued on page* 155)


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**American Institute of Chemical Engineers**
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# people

(*Continued from page* 153)

**George A. Richter** rejoins Brown Co., Berlin, N. H., where he spent over twenty years as director of research. He is to be a research consultant at Brown, after having spent the past six years with Eastman Kodak.

The Chemical Engineering Department of M.I.T. makes known the promotions of **William H. Ceckler** and **Thomas W. Mix** to the rank of assistant professors. Mr. Mix is also made director of the Engineering Practice School at Oak Ridge, Tennessee.

**Deane O. Hubbard** is appointed a specialist in chlorine plant design for the H. K. Ferguson Co., Cleveland. He has been associated with Hooker Electrochemical and Case Institute of Technology.

**Charles K. Schramm** is a new member of the staff of Esso Research and Engineering's chemicals research division, Linden, N. J. Before joining Esso he was with M. W. Kellogg, N. Y.

**Thomas Baron** is elevated to the position of department head of Shell Development's chemical engineering department at the Emeryville Research Center, Cal. Previous to this appointment he was assistant department head and had also been associated with the chemical engineering department of the U. of Illinois.

The development division at Emeryville promotes the following to the position of supervisor: **M. L. Courter,** who joined the firm in 1942, and has been in process engineering and done foreign assignment work; **E. G. Foster,** with the firm since 1952 when he had been on the chemical engineering staff of the U. of Louisville; **W. V. Medlin,** with the firm since 1935, and with process engineering for the past six years; **R. T. Milligan,** who joined the firm in 1944 and has been with processing engineering dept. since 1950; and **W. L. Snider,** whose first assignment was at Wilmington in 1944 and who transferred to process engineering department in 1950.

**Robert D. Hawthorn** is a new chemical engineer at the Emeryville Research Center, having received his Sc.D. degree from the U. of Washington this year.

The technical division of Mallinckrodt Chemical Works, St. Louis, appoints **Warren L. Towle** director of process development.

(*Continued on page* 156)


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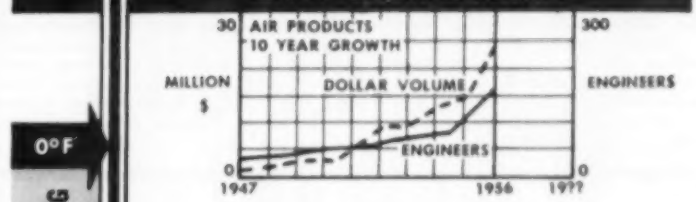


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# people

(*Continued from page* 155)

**August Merz** was recipient of one of six honorary doctor of science degrees conferred by the Lowell Technological Institute at a special convocation in observance of the Perkin Centennial. He was chosen because of his distinguished career in the fields of science, industry and public service.

Davison Chemical Co., Baltimore, in a realignment of organization functions, appoints **F. C. Nicholson** vice president and general manager of the chemicals division. **A. R. Worrall,** formerly manager of Davison's Curtis Bay Works, will head industrial chemicals.

**W. L. Kleiber** becomes manager of the Rochester plant of the industrial chemicals division of Olin Mathieson Chemicals Corp.

**Thaddeus S. Mroz** will perform equipment development work on nuclear propulsion equipment for ships at the Bettis Plant, Pittsburgh, which Westinghouse Electric operates for the Atomic Energy Commission.

The appointment of **Richard D. Dunlop** as executive assistant for manufacturing is announced by Monsanto Chemical Co., St. Louis. Since 1954, Mr. Dunlop has been assistant general manager of the plastics division.


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Al Mitka (left above) of A.I.Ch.E. Twin Cities Local Section presents the section's award to John Ahlquist. Prize is for the best solution to Annual Chemical Engineering Problem by a student at the U. of Minnesota.

**Yoonsik Lee,** of Taegue, Korea, joins the research department of Commercial Solvents Corp., Terre Haute, Indiana, where he will do research engineering and pilot plant studies. Prior to coming to the U. S., Mr. Lee was associated with the United Rubber Co., Korea, in a technical chemical capacity.

**Arthur Dreis** is promoted to assistant manager of the chemistry and chemical engineering research department at Armour Research Foundation of Illinois Institute of Technology. He had been associated with the Glatfelter Co. and Hercules Powder, and for the past two years has done consulting in paper products.

**Francis Curtis** represented the A.I.Ch.E. in a group of over 40 societies presenting congratulations to the Society of the Chemical Industry at its recent 75th anniversary meeting in London.

Monsanto Chemical's research and engineering division announces the appointment of **Robert E. Lenz** as assistant director of the central research department. Mr. Lenz will be headquartered at Dayton, Ohio, where he will direct the engineering research section of the department.

The appointment of vice president **J. Russell Wilson** as general manager of the domestic subsidiaries and affiliates division, a new division of Monsanto, St. Louis, is announced. Mr. Wilson has been general manager of the firm's research and engineering division since 1954. **Howard K. Narson,** who has been director of research and development for the organic chemicals division, becomes general manager of research and engineering, and **N. N. T. Samaras** is promoted to special assignment for the Executive Committee, having been assistant general manager of the research and engineering division.

**Wm. B. Stephenson** is elected president of the Allen-Sherman-Hoff Pump Co., succeeding **Homer E. Allen.**

(*Continued on page* 158)

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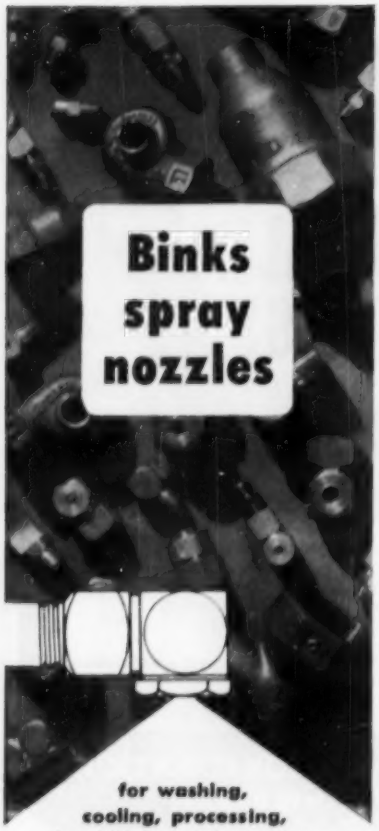


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# people

*(Continued from page 157)*

**John C. Simons, Jr.** joins the National Research Corp. to be director of applied physics in the research division. His background includes four years at M.I.T. as project engineer in charge of research on analog computers and fire control systems.

**William A. Raimond** promoted to technical director of American Cyanamid's organic chemicals division, where he replaces **James F. Bourland,** named technical director of Cyanamid's new engineering and construction division.

**Leonard Scribner** returns to Fansteel Metallurgical Corp. as assistant manager of the metals and chemicals div. He had been with Fansteel since 1937 except for the past two years, when he was associated with Crane Co.

**Jerome Gavis** joins the department of Chemical Engineering at Johns Hopkins U. as assistant professor. During the past two years he has been doing research in the field of rheology at the Army Chemical Center.

B. S. Pressburg, Dept. of Chemical Engineering, Louisiana State University, is shown (left) receiving the A.I.Ch.E. award for the best presentation of a paper at the recent New Orleans National Meeting. The paper, "Heat Transfer Coefficients for Condensing Organic Vapors of Pure Components and Binary Mixtures," was prepared by Dr. Pressburg and J. B. Todd, also of L.S.U. Presentation above is being made by L. A. Nicolai, chairman of the Baton Rouge Local Section of A.I.Ch.E.

**Charles H. Schuh** named technical advisor to the Union of Burma under a contract with Armour Research Foundation. He will work on the expansion of Burma Applied Research Institute at Rangoon.

**Murray H. Reich,** formerly with the Government Laboratories of the University of Akron, joins the polymerization section of the plastics and polymers department, Food Machinery and Chemical, N. Y.


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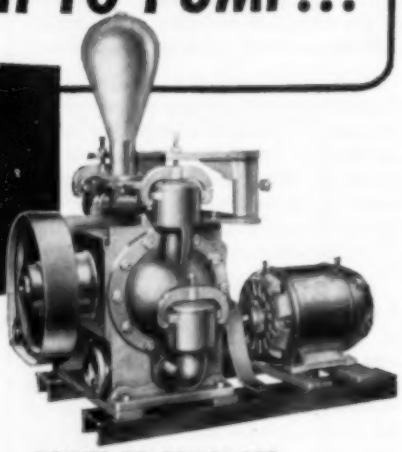

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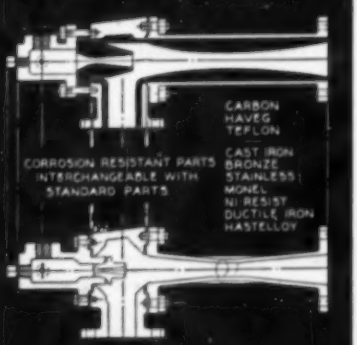


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## the chemical engineer in MARKETING

Sinclair Chemicals, N. Y., announces the appointment of **Ray C. Smith** as manager of domestic sales. He joined the Sinclair Research Laboratories at Harvey, Ill., in 1947 and rose to the position of section leader, lube processing section. In 1952 he was appointed manager of market development of Sinclair Chemicals.

**Ernest F. Blew,** sales representative for Hooker Electrochemical Co., Niagara Falls, is assigned to handle chemical sales in Wisconsin, Minnesota and Upper Michigan peninsula areas.

**C. Y. Haas** becomes manager of sorptive mineral sales at Minerals and Chemicals Corp., Menlo Park, N. J. He was assistant director of research prior to this appointment.

**Joe N. Butler** is appointed senior sales engineer on resin materials for Monsanto Chemical's organic chemicals division. Mr. Butler has been with Monsanto since 1939, transferred from operating supervision to sales in 1955.

**Richard C. Mathews** becomes field service engineer in the Houston office of Davison Chemical. He is attached to the petroleum catalyst department, and was previously with Standard Oil Co. (Indiana).

**Joseph Milgram, Jr.,** to Foote Mineral Co., Philadelphia as chemical sales engineer.

Badger Manufacturing, Cambridge, Mass., adds **A. W. Ackerman** to its N. Y. sales office staff to handle engineering, procurement and construction services in his field.

Davison Chemical, N. Y., division of W. R. Grace & Co., announces the appointment of **John Benedict** as district sales manager of the petroleum catalyst department. Joining Davison in 1950 as field service engineer, he has been located in the Houston office since 1954.

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**Jules Bebie,** 79, former professor chemical technology Washington U., St. Louis, and industrial consultant.


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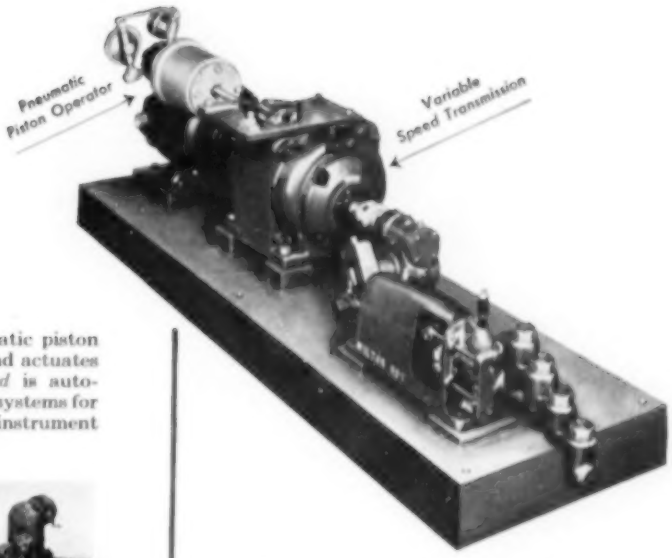
# news and notes of A.I.Ch.E.

**New Engineering Center.** More and more the attention of the Institute is centered on one of the major problems in the Institute's history, . . . that of the New Engineering Center and how we can join United Engineering Trustees . . . There was a lengthy Executive Committee Meeting of A.I.Ch.E. on August 20, along with members of the A.I.Ch.E.–U.E.T. Task Committee, to study the report submitted by B. F. Dodge, who was chairman of the Special Task Committee of the Founder Societies on the New Engineering Center, and another report from U.E.T. on probable conditions under which A.I.Ch.E. could join . . . Preliminary to a successful nationwide fund-raising drive for a new engineering building is the inclusion of A.I.Ch.E. in the U.E.T. . . . According to the report on our joining U.E.T., A.I.Ch.E. will be asked to raise from a minimum of $150,000 to about $550,000, the equivalent to the present equity of the four other societies in the Engineering Building . . . Since, at the end of July, the A.I.Ch.E. surplus was in the order of $170,000, a cash contribution of $150,000 would wipe out our surplus . . . since the Kelly Committee has asked us not to compete in an industry appeal for funds, one can see difficulty in store for A.I.Ch.E. . . . This then is the crux of the problem Council will spend all day Saturday, September 8, discussing at Pittsburgh . . . how will A.I.Ch.E. raise the money necessary to join with the other groups? . . . Much of the Executive Committee discussion cannot be reported now since it consists mainly of recommendations to Council . . . Then too, there are many questions yet to be answered . . . Can the 39th Street site be refurbished? . . . How many square feet are needed? . . . What will be the cost, etc.? . . . U.E.T. is prepared to go ahead with architectural and cost studies and has asked A.I.Ch.E. to share in them . . . this will amount to $10,000 . . . The Executive Committee recommended that Council agree, since we were part of the Task Committee and such planning will include our needs . . . By the time the members read this column, though, Council will already have considered the problem and more news will be in the next issue . . . In the meantime, should any members have questions or suggestions, do not hesitate to write. . . . **Executive Committee actions** . . . Six Engineering Societies including the A.I.Ch.E. have agreed to sponsor a joint award honoring Charles F. Kettering . . . The award, which will be for outstanding contributions in invention, will be presented this fall to Kettering as the first recipient . . . Executive Committee approved A.I.Ch.E.'s joining the board which selects a recipient every year . . . the chairman of the A.I.Ch.E. Awards Committee, Ed Gilliland of M.I.T., has been chosen as one of the appointees to this board. **Contests for Members.** The 50th Anniversary Committee . . . all ex-presidents . . . is planning quite an event for June, 1958, and has announced with Executive Committee approval, two contests . . . the first, for a theme suitable to the 50th Anniversary of the Chemical Engineers and the second for a design which can be worked into the program, medals, etc., depicting the meaning of Chemical Engineering to our present world . . . The prizes will be $250 to each winner . . . more about this later when additional rules have been formulated . . . A special certificate is to be drawn up also for presentation (at that meeting for the first time) to members who have completed 50 years of membership in A.I.Ch.E. **Program Committee.** Program Committee is stepping up activities and many important symposia are being planned . . . **Institute Lecturer** will be W. K. Lewis, who will talk at the Boston meeting on "Engineering as a Profession" . . . . K. C. Brown of Emery Industries is Technical Program Chairman for the Cincinnati Annual Meeting in December, 1958 . . . .

**Cooperative Conferences.** A.I.Ch.E. & A. S. M. E. are cooperating in several conferences . . . the First National Conference on Heat Transfer, honoring William H. McAdams of the Massachusetts Institute of Technology, to be held at the Pennsylvania State University on August 11-14, 1957 & a Joint Instrument Symposium, which will be held at Northwestern University on April 8-9, 1957 . . . A.I.Ch.E. members working on the Heat Transfer program are Neal Addoms, Atlas Powder Company, Chairman; C. H. Brooks, Sun Oil Company; George Skaperdas, The M. W. Kellogg Co.; & E. T. Williams, Pennsylvania State University . . . David M. Boyd, Jr., of Universal Oil Products Co. is the A.I.Ch.E. representative on the Instrument program.

F.J.V.A.

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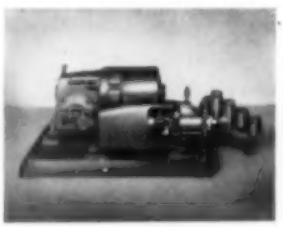

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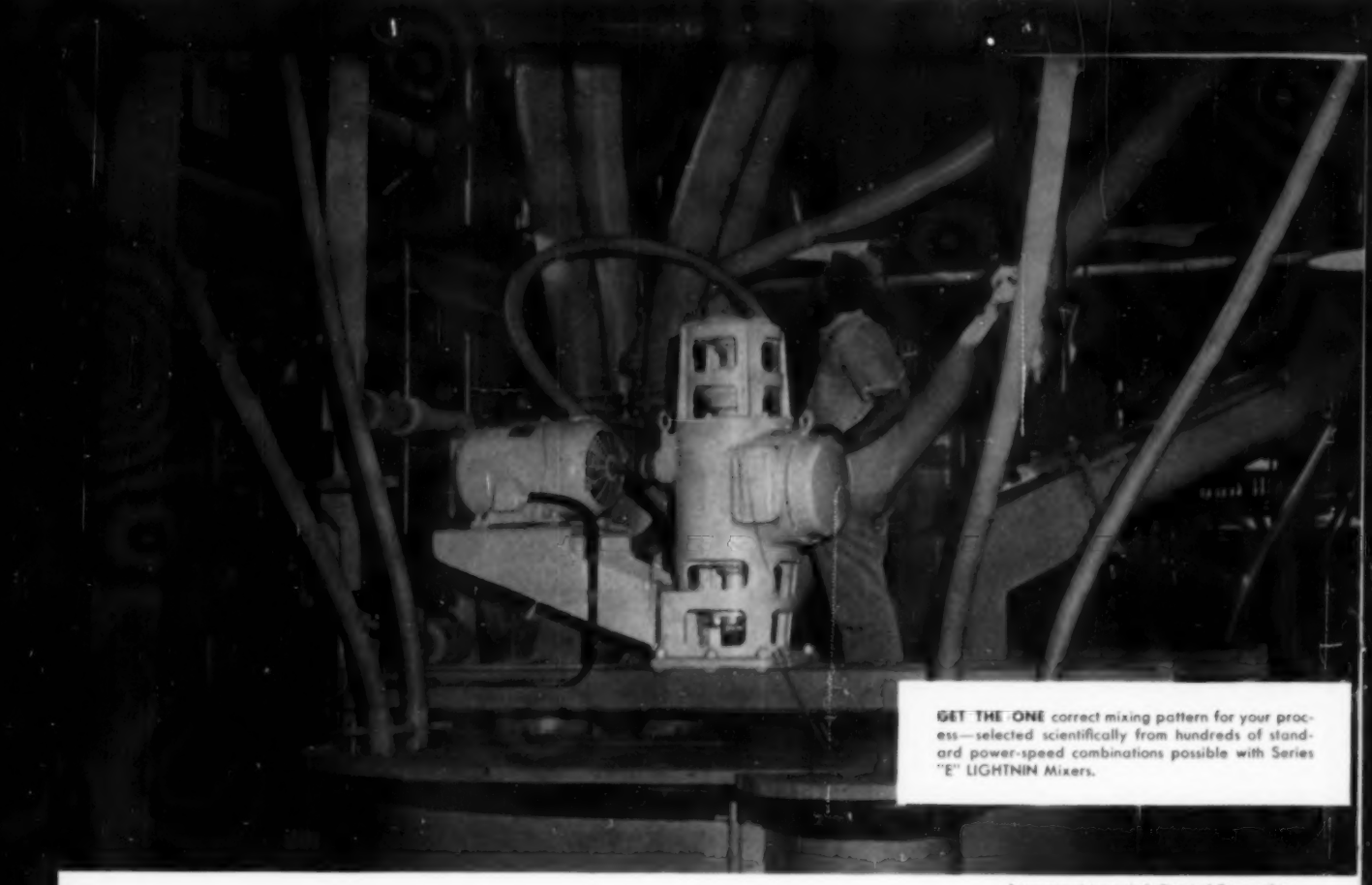

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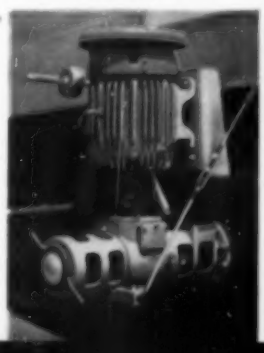
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